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TWELFTH ANNUAL REPORT

OF

THE LOCAL GOVERNMENT BOARD

1882–83.

SUPPLEMENT

CONTAINING THE

REPORT OF THE MEDICAL OFFICER

For 1882.

Presented to both Houses of Parliament by Command of Her Majesty.

THE PROPERTY OF THE N. YORK HOSPITAL

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ANNUAL REPORT

OF THE

MEDICAL OFFICER

OF

THE LOCAL GOVERNMENT BOARD

FOR THE YEAR

1882.

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REPORT.

TO THE RIGHT HONOURABLE SIR CHARLES WENTWORTH DILKE, BART., M.P., PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

SIR,

MEDICAL OFFICER'S REPORT.

IN supplement to the Board's Twelfth Annual Report I have the honour to submit to you an account of the more special proceedings taken in your Medical Department during the year 1882.

I.—VACCINATION.

Vaccination returns.

(*a.*) Analysis made in the usual way of the returns of local vaccination officers, with regard to children whose births were registered in the year 1880, shows, except as regards 4·69 per cent. of the births, the vaccination of all the children born in England and Wales during the year to be accounted for in the local registers. Owing, in chief measure to the more moveable character of the population of the London parishes, the children born in the metropolis habitually show a larger proportion of omissions than children born elsewhere in the kingdom, and during the year 1880 this proportion amounted to 7 per cent. of the births, while, among those born elsewhere, it reached to 4½ per cent. only. For extra-metropolitan England this per-centage is the same as that for the preceding year; for the metropolis it is smaller than in 1879.

Inspection.

(*b.*) During the year 1882 public vaccination, with which the Board is more particularly concerned, was as usual supervised by the inspectors of the medical department, and 284 unions, comprising 1,350 vaccination districts, were visited in the year.

Awards of money from the Parliamentary grant were made on the recommendation of the inspectors to contractors for public vaccination in respect of 751 of these districts. In these the public vaccinators had, according to inspectors' reports, discharged in a satisfactory manner the duties imposed on them by their contracts with the guardians. In other districts there had been more or less of departure from contract duty; or, for some other cause, an award could not be made.

II.—SECURITY IN VACCINATION. INSTRUCTIONS TO PUBLIC VACCINATORS. FOREIGN VACCINATION.

Security in vaccination.

In my last report, when demonstrating a saving of 12,000 lives of London children that would, but for vaccination, have been sacrificed to small-pox in 1881, I had occasion to mention 12 deaths registered as having been caused by cow-pox and diseases

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occurring after vaccination in London during the same period; and I stated that inquiry into the facts of the several deaths had shown that the cause of death was, with hardly an exception, erysipelas. The Registrar General's Report for 1881 has since been issued, and it shows the mortality registered as from cow-pox and conditions regarded as effects of vaccination, was, for England and Wales with a population nearly seven times as large as London, not quite five times the amount ascribed to such causes in London in 1881.

During the year 1882 inquiries were held by inspectors of the department into cases of fatal erysipelas, occurring after vaccination, at Norwich and Derby. The results of the Norwich inquiry have already been submitted to Parliament. In the other case, a proved slovenliness on the part of the vaccinator led to the conclusion that septic infection had probably been conveyed by some dirty appliance used in the operation. The operator was consequently required to resign his appointment as public vaccinator. Inquiry was also made as to an alleged death by vaccinal syphilis at Wolverhampton; here the syphilis was certainly not conveyed by the vaccination, but was congenital in the infant.

Instructions to public vaccinators.

The Board's Instructions for Public Vaccinators are designed to attain the greatest efficiency of vaccination while avoiding all risks incidental to the operation. These instructions are, by the terms of their contracts, binding on Public Vaccinators, and as the reports of the medical inspectors show, they have usually been obeyed by the contractors. Serious disobedience to them was but rarely met with. But, as there are still some vaccinators, even some few public vaccinators, who do not vaccinate in the most efficient manner, so there are also some who neglect to take the full measure of precaution which, as practitioners performing an important operation upon patients, they ought to take.

The occurrences at the Norwich Vaccination Station in the summer of 1882, have shown the necessity for introducing another formal instruction into the Board's code. It is designed to prevent the accidental inoculation of any trace of septic matter, and thus to reduce the risk of erysipelas or similar disease. It enjoins the vaccinator never to use a point, glass, or tube *a second time*, either for the conveyance or the storage of lymph.

For the prevention of accidental inoculation of syphilis during vaccination, experience shows the precautions at present formulated in the Board's Instructions to be sufficient. Experimentally, indeed, Dr. Cory has recently succeeded in communicating to himself syphilis with vaccine lymph unmixed with blood, but he did so only by purposely setting aside two precautions of the Instructions, and setting them aside in such manner as no medical practitioner is likely by any accident or carelessness to imitate. His experiments are the subject of an appended Report. (Appendix A., No. 7.)

Vaccination in foreign countries.

At the instance of the Board inquiry has been made by the Foreign Office as to the laws regulating the practice of vaccina-

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tion in the several countries of Europe. In the appended paper (A., No. 6) is given the substance of the replies, together with a variety of information respecting the actual observance of vaccination and the prevalence of small-pox. A general increase of stringency in requiring vaccination is observable in the laws of various countries since the severe epidemic of small-pox in 1870–71. Throughout the German Empire the operation has been obligatory since 1875. On the other hand a proposal for uniform compulsory law throughout the Swiss cantons was rejected by the popular vote in 1881, the cantons objecting, it would seem, to transfer to the Federal Government what they regarded as being their own legislative functions.

III.—National Vaccine Establishment.

Supply of humanized lymph:

(*a.*) *Humanized Lymph.*—The customary supplies of this lymph were received in the National Vaccine Establishment during 1882. They were derived from certain large public stations at which during the year an aggregate of 24,391 primary vaccinations were performed. Charges of lymph, selected by the experienced vaccinators of these stations were received to the number of 5,089 points, 40 glasses and 13,861 tubes. A further number of 8,056 tubes was received from certain approved public vaccinators in supplement to the usual sources of supply. These charges were all examined within the department and were distributed in response to 9,142 applications, principally for the purpose of commencing local series of vaccinations. Representations as to irregularity or abnormal symptoms in the course of the resulting vaccinations were received from six of the applicants.

of animal lymph.

(*b.*) *Animal Lymph.*—With my account of the proceedings of the Medical Department during 1881, I presented a Report by Dr. Cory on the earlier proceedings of the Animal Vaccine Institution established in that year by the Board. The business of that institution has progressed satisfactorily during 1882, in spite of certain difficulties introduced into its working by the prevalence of foot-and-mouth disease in the country. In an appended Report (A., No. 3) by Mr. Shirley Murphy, who has recently been acting for Dr. Cory, the history of the operations at the Lamb's Conduit Street Station is continued and brought down to the end of March 1883. The chief practical interest in this report consists in the indications that are beginning to appear that there is much less difference than has heretofore been supposed between calf lymph and humanized lymph. Certainly the care and judgment wanted for proper selection of lymph in the case of the one are wanted in the case of the other; as in the child, so in the calf, there are peculiarities of individuals to be apprehended; imperfect and irregular vesicles to be avoided; development of special characters in the lymph during successive cultivations to be watched for. And, under the actual conditions of lymph selection and of operation observed at Lamb's Conduit Street and at Surrey

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Chapel respectively, there has recently seemed little to choose between the one and the other kind of lymph, either in respect of insertion success or in respect of local and constitutional effect produced; further, the influence of storing upon the activity of the lymph, at one time believed to be more rapid and more pronounced in the case of the calf product, is now appearing to be not very different in the case of humanized lymph and calf lymph. But more extended experience will have to be obtained before an identity of the two kinds of lymph in these several respects can be affirmed or denied.

Between the opening of the Lamb's Conduit Street Station in April 1882, and the end of the year 3,655 points, and 471 tubes charged with animal lymph were sent from that station to the National Vaccine Establishment. Applications for this particular kind of lymph to the number of 589, were received in the establishment; and, mostly in reply to these applications, 2,872 charged points, and 270 tubes were sent out. Some animal lymph was also supplied for the use of the army and navy; but for the most part these services were supplied with humanized lymph. Very little information as to the results of vaccination with animal lymph, or as to its specialities, has been afforded by those to whom it has been sent.

IV.—Local Inquiries by Medical Inspectors.

Local medical inquiries.

Inquiries as to local prevalences of disease were undertaken in 31 instances and extended to the districts of 46 sanitary authorities. They were most usually called for by local request or complaint made on the occurrence of some epidemic disease. They had concern most commonly with diphtheria or enteric fever; in other cases with scarlatina, typhus, diarrhœa, and small-pox.

The Board have lately, at the instance of some officers of health and others interested in sanitary knowledge, given sanction to a new practice in respect of this class of reports. Such of them as are judged to contain experiences of more than local interest are now placed on sale, as Stationery Office publications.*

Diphtheria at Pirbright.

(*a.*) A very remarkable experience of diphtheria is recorded by Mr. Power (Appendix A., No. 8) from the parish of Pirbright, near Guildford. On four successive occasions, while the village school was open, well-marked diphtheria appeared among the scholars, who carried the disease home to their respective families; and this although the school premises were free from recognizable sanitary defect, and although the school was not, after its first closure, re-opened until the disease had seemed extinct in the parish, and careful measures of disinfection had been used. There did indeed appear indications that the actual bringing together of children was responsible for a serious specific quality attaching to throat

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ailments which otherwise would have been trivial. Mr. Power's report is worthy of the most attentive study, particularly by those who have opportunity of watching the behaviour of diphtheria in rural communities.

Spread of scarlatina by milk.

(*b.*) Of late years, since medical practitioners have given attention to the means of distribution of infectious diseases, an increasing number of local outbreaks of enteric fever, of scarlet fever and of diphtheria, have been recognised as spread through local communities by means of milk. In such outbreaks, contamination of the milk by the material of specific disease derived from some antecedent case in the human subject has been of necessity the first explanation that has offered itself for acceptance; and in many such outbreaks, this explanation has appeared valid and sufficient. But, in outbreaks of scarlatina more especially, such a hypothesis of the manner in which the milk may have obtained its specific quality has not always accorded with the observed facts; and not unfrequently it has appeared, during recent epidemics, that for all we can affirm to the contrary the endowment of the milk with harmful attributes may be an affair of the very system of the animal furnishing the milk. A notable illustration of this class of outbreak is given in an appended paper (A., No. 9). Here is an account of scarlatina in several London districts appearing at the same moment among many consumers of a particular milk and not among their neighbours. It can be said that the milk was unquestionably the vehicle of the epidemic: yet the history of that milk could be traced with a good deal of assurance from its leaving the cow at a Surrey farm to its delivery in houses of central London, and no method by which it could have received the infection of human scarlatina was to be suggested as in any way probable. Thus, a hypothesis that the milk actually possessed, at the moment of entering the pail, the power which it assuredly had of producing scarlatina in the human subject, forced itself upon consideration; and, although indeed the thing was beyond customary experience, such a hypothesis was seen to accord with the observed facts of the outbreak. In this position of the question, research into the liability of the cow to suffer from disease of a nature allied to scarlatina has been begun for the Department by Dr. Klein. He has found that a cow, having recently calved, when inoculated experimentally with human scarlatina, is affected by an ailment which is transmissible, after the manner of an acute specific disease, to dogs; that this ailment in the cow is not accompanied by any marked fever, does not take her off her food, and does not alter the quantity or visible characters of her milk. Its symptoms are not such as would be recognised as forbidding the use of the cow for dairy purposes. Further inquiry is wanted to show whether the animal is liable, without such artificial inoculation, to suffer from similar ailment proper to her own system.

Enteric fever at Bangor.

(*c.*) At Bangor, in June 1882, enteric fever, which had previously been of occasional occurrence only in the city, suddenly assumed

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serious proportions, and was the subject of investigation for the department by Dr. Barry. He obtained very strong circumstantial evidence that the public water supply had on a particular occasion become polluted by river water flowing over the filter beds and carrying with it the accumulated dirt from the filtering surface and also excrements that had been discharged into the river; there was reason for believing that among the latter were the discharges of certain enteric fever cases. Upon the recognition of this mechanism of the fever distribution, efficient steps for securing the water-supply against further pollution were adopted, and the epidemic rapidly declined, but not until it had caused 548 cases of sickness and 42 of death in Bangor and its immediate neighbourhood. Dr. Barry's report forms one of the appended papers (A., No. 10).

near Uxbridge, and at Sherborne.

(*d.*) Two smaller outbreaks of the same disease that were the subject of inquiry by the department during the year exhibited peculiarities of more than passing interest (Appendix A., Nos. 11 and 12). The one occurred at Norwood, near Uxbridge, the other at Sherborne, in Dorsetshire. They both illustrate instructively, but in different ways, how greatly the prevalence of this fever is an affair of local sanitary administration.

Malignant pustule in London hide-trades.

(*e.*) In the present volume I have included a report by Mr. Spear upon an inquiry, begun during the first quarter of 1883, as to the occurrence of malignant pustule among persons engaged in the London hide and skin trades. The disease is the external manifestation of that anthrax which has already been the subject of report to the Board as it has appeared among horsehair workers at Glasgow and among woolsorters at Bradford and other districts of Yorkshire (Medical Officer's Reports, 1878, p. 321, and 1880 p. 66). It is now recognized as of occasional occurrence in the metropolis, more particularly taking patients to Guy's Hospital from the tanyards of Southwark; but, as in other towns, being practically restricted to those whose occupation brings them into contact with foreign hides or like products. Particular consignments of Chinese ox hides appeared to be specially concerned with the cases now recorded. I have already, in my report for 1880, considered the nature of the measures calculated to lessen the risk of this disease among woolsorters: and some further suggestions applicable to the circumstances of the trade in hides are made by Mr. Spear in the present report (Appendix A., No. 13).

Other local inspections.

(*f.*) In addition to inquiries about prevalences of disease, inspectors of the Medical Department have made 23 other visits to the districts of sanitary authorities, in cases where the Board desired to have skilled observation respecting some matter concerning the health of the district, or to convey to a sanitary authority their views respecting some medical question involved in local health administration. In 15 of these instances the visit had reference to proposals for the provision of isolation hospitals.

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V.—Other Administrative Proceedings.

Medical Officer's Report.

Administrative duties of Medical Department.

I do not propose on the present occasion to refer otherwise than casually to the functions with which your Medical Department is charged of advising on questions concerning health and disease that arise out of the Board's daily relations with sanitary authorities and others. During 1882 the functions involved some 5,000 recorded references to the Medical Officer; with the examination of many hundred of reports—annual and special—made by local health officers, consultations on plans for hospitals, on proposals for byelaws, for sanitary works, for appointment of officers, and a variety of other matters. I confine my observations under this head to some few important proceedings in which the Department was more prominently concerned.

Dr. Blaxall's emigration inquiry.

During the year, the Board directed inquiry into the sanitary aspects of British immigration and emigration practice. The more immediate occasion of this inquiry was found in representations from the United States that small-pox was believed to have been imported into that country by immigrants from Europe.

This inquiry, entrusted to Dr. Blaxall, took into account the movements of British and Irish population to various colonies as well as to foreign countries, and also considered the practice of emigration from the Continent of Europe to the United Kingdom and across Great Britain on the way to North America. It examined the conditions of travel and lodgment of immigrants and intending emigrants and also the sanitary arrangements on board of emigrant ships: and Dr. Blaxall has brought back a mass of useful information respecting the precautions actually taken at ports of disembarkation, in lodging houses, at ports of departure and on shipboard; for maintaining health, for detecting infectious disease, and for guarding against the spread of infection. Dr. Blaxall's Report (Appendix A., No. 14) shows a great amount of intelligent forethought bestowed upon the business of immigration and emigration in its commercial aspect, and a great and always increasing amount of solicitude given, by those who undertake the responsibilities of directing emigration, to the health of emigrants as well as to the more obvious conditions of their comfort. It has appeared, as a result, that the quantity of preventable sickness spreading in emigrant ships leaving the United Kingdom or transmitted through their agency cannot be reckoned as large, when the exceptional conditions of the people are taken into account. He does not give so favourable a picture of the arrangements made for detecting infectious disease among persons arriving on our shores from continental countries; and in this light his report demands the careful consideration of the sanitary authorities of our own ports.

Dr. Blaxall points especially to the lack of organised relation between shipping companies and sanitary authorities, and to the need for one and another measure of co-operation among these bodies, and he is particularly anxious for regular medical inspec-

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MEDICAL OFFICER'S REPORT.

tion of foreigners landing in English ports. The various suggestions which Dr. Blaxall has made for improvement in our sanitary practice in ports and on shipboard have the sanction of his old naval experience, and he does not foresee any real difficulty in the attainment of them in practice. Referring for details to the text of the report, I need only observe, further, that Dr. Blaxall's representations have already been the means of introducing useful securities to health in one or more of our English ports.

Dr. Ballard's diarrhœa inquiry.

Dr. Ballard was engaged during a certain portion of the year in a continuation of his investigation of infantile diarrhœa in England, and the conditions of its prevalence and fatality, with the object of gaining some insight into the causes of the disease and the means of its prevention.

I need put forward no excuse about the length of time over which his inquiry is extending. The importance and difficulty of the work may be judged of, when it is recalled that this infantile diarrhœa, manifesting its whole intensity during a very few weeks of the year, is fatal on the average to 15 out of every 1,000 children born in England and Wales, in some years to double as many as in other years; that there are some towns where its average mortality closely approaches 50 out of every 1,000 children born, and where its mortality in some years is three or four times what it is in other years; and lastly, that before Dr. Ballard's inquiry hardly an effort had been made to understand the disease, its obvious association with hot weather having been almost all that was recognised in regard of its cause.

Infectious hospital inquiry.

During the year 1882, in addition to my usual report on the current work of the Department, I had the honour to present to your predecessor a paper on the Use and Influence of Hospitals for Infectious Diseases. In this paper I recorded the results of inquiries made by Dr. Thorne and Mr. Power into the conditions for the greatest usefulness of such hospitals regarded as places for the treatment of patients and as institutions for the protection of communities against the spread of infection. I had to take account of certain drawbacks to the usefulness of hospitals that had been met with in practice, particularly in the practice of London hospitals for small-pox. It had appeared from the experience of one of the hospitals of the Metropolitan Asylums Board that small-pox had during successive years exhibited a power of extending from the hospital to the houses of the neighbourhood; and this, not by reason of faults in administration, but, as it appeared, by the dissemination through the atmosphere of small-pox material from the very hospital itself.

The Royal Commission which was appointed for the investigation of this subject as it affected the Metropolis has very critically examined the evidence collected by Mr. Power in his Fulham Hospital inquiry, and has given a virtual acceptance to Mr. Power's facts and inferences. And further extending its investigations to the experience of other metropolitan small-pox hospitals, the Commission has arrived at the more general conclusion "that

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"large small-pox hospitals in populous neighbourhoods have "proved appreciable sources of infection" to their neighbourhoods. MEDICAL OFFICER'S REPORT.

The report of this Commission was presented to Parliament in August 1882. It contains, on the one hand, certain practical recommendations which have for their primary object to secure a more efficient management, under the auspices of the Metropolitan Asylums Board, of infectious disease occurring among the inhabitants of London; and upon this section of its recommendations your Board will be advised by Dr. Bridges. On the other hand, the report of the Commission contains much important matter of interest for your Medical Department. It considers how popular objections to infectious hospitals can best be removed, how such hospitals may be utilized for the greatest advantage of communities, what facilities can be obtained for the acquisition of hospital sites, and what securities against sudden interruption of hospital operations; and further it refers to the probability of attaining, by the adoption of various precautions and contrivances in the administration and cons ruction of small-pox hospitals, a fuller assurance of safety to neighbouring dwellings. Report of Commission.

A re-issue of the memorandum of the Medical Department "On the Provision of Infectious Disease Hospitals" is now in course of preparation. Based, like the former issue, upon the experience gathered by the Department from the actual working of such hospitals in English communities, and having now a longer and a wider experience as its basis, the memorandum is designed for the assistance of local sanitary authorities throughout the kingdom. In the preparation of this memorandum regard is had to the advice of the Royal Commission on Metropolitan Hospitals. Memoranda of Medical Department:— as to hospitals.

Mention was made in my last report of the new Code of the Education Department of the Privy Council, issued in March 1882, and of the power conferred upon sanitary authorities, by Art. 98 of the Code, to direct precautions to be taken with the object of preventing the spread of infectious disease by means of public elementary schools. A good deal of experience has already been gained in your Medical Department as to use of one or another measure of this kind, and as to the conditions under which it is desirable in the interests of health to exclude scholars coming from infected houses, or, on the other hand, to close the schools of a district. I have placed in the Appendix (A., No. 15) some memoranda embodying this experience, in the hope that they may prove helpful equally to those authorities of a district that are charged with its education and to those whose first care is for its health. as to schools.

VI.—Auxiliary Scientific Investigations.

Dr. Klein has continued his investigations into the relations of pathogenic bacteria, with the intention of further testing the expectation held out by M. Pasteur and others of a general law, Mutations of micro-organisms: Dr. Klein.

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applicable to all kinds of virus, that it may be possible to produce for every infective virus, an attenuated form of it which shall be capable of inoculation into susceptible animals, availing to produce in them a modified form of the infective disease protective thenceforward against serious attack of the disease. (Appendix B., No. 1.)

"Vaccin" of anthrax.

Again experimenting with the bacilli of anthrax, Dr. Klein has extended his observations to sheep, but with results in the main negative. In some way or other his anthrax "vaccin" differs from that which has been produced by M. Pasteur. One cultivate, grown at 22° C., did indeed, when inoculated into a sheep, give rise to a slight illness, after recovery from which the sheep was not susceptible of the disease. But for the most part Dr. Klein's experience on sheep was similar to his previous experience with rodents; either he obtained no result whatever from inoculation with his artificial cultivate, or else the animal was killed by it, as it would have been by inoculation with the original anthrax. Dr. Klein places on record, however, one observation that may prove to be of large pathological interest. In his experiments of this year he used the blood of a mouse dead of anthrax for inoculation into three sheep, with the result of producing in each sheep only a slight constitutional disturbance, after which the material of virulent anthrax could be inoculated into the sheep without effect upon it. Here, apparently, through the influence of change in the species of animal intermediately used, he did procure a "vaccin" that had the desired ability, such as he had sought, with very imperfect success, to obtain by any of the methods of artificial cultivation that he employed.

Dr. Klein further reports the results of his experiments with certain artificial cultivates issued from M. Pasteur's laboratory, and sold as "vaccin charbonneux." Tubes of this material, obtained from M. Pasteur's agent, M. Boutroux, of Paris, were used for the inoculation of sheep, guinea-pigs, and mice. Of the specimens received by Dr. Klein, those sold as "premier vaccin" proved to be in most instances inert, even on the rodents; not availing to protect them against death by subsequent inoculation with anthrax material; while the animals that were affected at all by this premier vaccin were affected fatally by it. The effects of inoculation with the "deuxième vaccin" were more intense, but otherwise were similar to those observed in the use of the premier vaccin; either the animals were affected by it very little or not at all, and were left as susceptible as before to the fatal disease; or else they were killed by the anthrax which the "deuxième vaccin" itself produced. Obviously the particular specimens obtained from M. Boutroux had not the power claimed for them, of causing a modified and protective form of anthrax, and it cannot but be inferred that the substances issued from M. Pasteur's laboratory are extremely uncertain in quality. Probably the conditions for the manufacture of a true attenuated anthrax-virus are numerous, and are not all understood even by M. Pasteur himself; and this makes it more a matter for regret that the precise details of the methods

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which he adopts are not yet published by M. Pasteur for the information of his fellow-workers.

Of this virulent disease, known as anthrax, which has at various times caused sad devastation among the animals that furnish food to man, and which occasionally produces serious disease in the human subject, it was formerly asserted that it had a strange ability to retain its virulence in the corpses of ts victims. Dr. Klein's researches of the past year have appeared to demonstrate some fortunate limitations to the correctness of this doctrine. Provided that the body of a guinea-pig dead of anthrax be not opened after death, the changes which take place in the bacillus of the disease within the dead body are purely degenerative, and the blood and organs of the animal soon lose their power of communicating the disease by inoculation; and this is equally the case whether the dead body be buried or not. Only in the event of there being wounds on the body or of the body having been opened after death, the anthrax bacilli are capable (as they are when contained in evacuations from the creature) of entering into new generations; and at the stage of spore-formation the bacillus becomes again able to withstand ordinary destructive influences, the spores retaining the power of infection for an indefinite time. Dr. Klein's observations on these matters are confirmatory of those announced by Koch in 1881.

Researches as t disinfectants.

Recent advances in our knowledge of the affinities and of the probable nature of the matter of infection have permitted definition to be more clearly made of the objects that we seek to attain by the use of disinfecting agents. This has been done by Dr. Sanderson in an appended memorandum (B., No. 2). He here points out that research after substances endowed with disinfective powers may be expected to aid to a better understanding of the nature of infective actions themselves; and he indicates from the standpoint of our present knowledge, the directions which may best be followed for the discovery of such agents, potent for the control alike of septic and of specific contagia outside the living body, and perhaps antagonistic to the operation of contagia within the body. Your sanction has been given to a design for commencing without delay some sustained researches, upon the lines indicated in Dr. Sanderson's memorandum, into the behaviour of some better known contagia in presence of various colytic agents.

Chemistry of brain: Dr. Thudichum.

Dr. Thudichum has now completed those profound researches into the chemical composition of the brain on which he has been so long engaged for the Board. In his appended paper (B., No. 3), he records some further studies of the phosphorized principles of the brain, and proposes new views as to the grouping of elements within those complex substances which he and other chemists have obtained by analysis of the several parts and tissues of the nervous system: substances to the number and understanding of which he has himself principally contributed. His researches have shown, he says, the brain to be the most diversified chemical laboratory of

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MEDICAL OFFICER'S REPORT.

the animal body; all other organs being much more simple, and very much less specific in their chemical constitution than the organs producing and conducting nerve power. Classifying afresh the immediate principles of the brain, and their derivatives which he has discovered, he has now, in the concluding report, summarized the various principles of the brain, phosphorized and non-phosphorized, nitrogenized and non-nitrogenized, assigning to each its chemical formula, and the formula of its chief compounds; and without professing to have exhausted this most arduous subject, he exhibits a mass of research into the chemistry and chemical operations of the nervous system which will form a new point of departure for the biologist and supply a body of reference for the observer of vital processes whether in health or in disease.

VII.—CONCLUSION.

Mr. Radcliffe's retirement.

In concluding this report, I have to lament the serious loss that this Department has sustained by the retirement, owing to ill-health, of Mr. Netten Radcliffe from the office of Assistant Medical Officer to the Board. In one respect, this event is of concern to the whole Government. Mr. Radcliffe's singular powers of gathering information respecting foreign epidemics, and of appraising the medical significance of facts and rumours concerning them, have been repeatedly illustrated in these reports, and have led to his counsel being highly valued by the Foreign Office and Colonial Office, as well as by your Board.

During the year 1882, a number of references were made to your Board by the Privy Council, the Foreign Office, and other Departments of State, with the object of obtaining the advice or assistance of your Medical Department. In these questions the health and commerce, not only of Great Britain, but of Europe, were concerned; and, for the last time, Mr. Netten Radcliffe afforded to the Government his experienced services in respect of them.

I have the honour to be, Sir,
Your obedient Servant,

GEORGE BUCHANAN.

December 31st, 1883.

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APPENDICES.

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APPENDICES.

APPENDIX A.

No. 1.

DIGEST of the VACCINATION OFFICERS' RETURNS, with regard to CHILDREN whose BIRTHS were registered in the Year 1880.

The following is the ninth annual return under the Vaccination Act, 1871. Of 881,652 births returned to the Board by the several Vaccination Officers in England and Wales as registered during the year 1880, the number which at the time the return was made had been recorded as successfully vaccinated was 750,203 (being 85·1 per cent. of the whole), and the number returned as having died before they could be vaccinated was 87,361 (or 9·9 per cent. of the whole). Of the remaining 44,088 children, 859 (or 0·097 per cent. of the whole) had been recorded as insusceptible of vaccination; 46 (or 0·005 per cent.) as having contracted small-pox before they could be vaccinated; 5,930 (or 0·67 per cent.) as having their vaccination postponed by medical certificate; leaving 37,253 (or 4·2 per cent.) as "removed," "not to be traced," or otherwise unaccounted for. If from the 881,652 births returned by these Officers, deduction of the deaths without vaccination be first made, it appears that of the surviving 794,291 children, there were registered at the time of the return 94·4 per cent. as successfully vaccinated; 0·11 per cent. as either insusceptible of vaccination, or as having had small-pox; and 0·75 per cent. as under medical certificate of postponement; leaving 4·69 per cent. as at that time still unaccounted for as regards vaccination.

Of the 37,253 cases which this last per-centage represents, the majority were children who could not be found by the Vaccination Officers, usually because of the removal of the parents from the place of birth. The remaining cases in the last column (with the exception of a certain number in which vaccination had really been performed successfully, but which could not be registered as vaccinated on account of the legal certificate of vaccination not having been received by the Vaccination Officer) were cases which, at the time of the return were still unvaccinated in the union or district.

The results continue to be less complete in the metropolis than in the rest of the kingdom, and the proportion of cases unaccounted for in the metropolitan returns for 1880 is 7 per cent.

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App. A. No. 1.

Digest of Vaccination Officers Returns.

The percentage in the rest of the kingdom, which was 4·5 in 1879, was 4·5 in 1880. Of the registered births of the nine years 1872–80, the proportion not finally accounted for in regard to vaccination in each year respectively has been as follows:—

	Metropolis.	Rest of England.
1872	8·8	4·5
1873	8·7	4·2
1874	8·8	4·1
1875	9·3	3·8
1876	6·5	4·0
1877	7·1	4·1
1878	7·1	4·3
1879	7·8	4·5
1880	7·0	4·5

In 1880, the proportion of cases unaccounted for, after deduction of the postponed cases, in the metropolis and in the rest of the kingdom, was 6·6 and 3·8 per cent. of births respectively.

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Returns, 1880.

	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
ENGLAND & WALES	881,652	750,203	859	46	87,361	5,930	37,253	4·9
Ditto excluding Metropolitan Unions.	748,346	638,553	596	11	75,322	5,351	28,513	4·5
Metropolitan Unions	133,306	111,650	263	35	12,039	579	8,740	7·0
Counties.								
Bedford	5,009	4,222	5	—	618	34	130	3·3
Berks	7,776	6,853	6	—	682	75	160	3·0
Bucks	4,872	4,253	3	—	499	35	82	2·4
Cambridge	5,844	5,074	5	—	612	26	127	2·6
Chester	20,304	17,646	22	4	1,907	108	617	3·6
Cornwall	9,469	8,040	3	—	1,165	68	193	2·8
Cumberland	8,508	7,479	5	—	756	74	194	3·1
Derby	13,969	11,817	14	—	1,411	68	659	5·2
Devon	18,224	15,983	15	—	1,620	151	457	3·3
Dorset	5,509	4,906	3	—	434	52	114	3·0
Durham	33,200	27,586	10	1	3,728	299	1,576	5·6
Essex	18,534	16,076	23	2	1,612	109	712	4·4
Gloucester	16,478	14,334	15	—	1,457	99	573	4·1
Hereford	3,420	2,924	4	—	314	36	142	5·2
Herts	7,172	6,434	3	—	598	20	117	1·9
Huntingdon	1,558	1,380	—	—	139	18	21	2·5
Kent (extra-metropolitan)	22,586	20,012	25	—	1,869	178	502	3·0
Lancaster	127,896	107,991	83	—	13,535	850	5,437	4·9
Leicester	11,910	8,909	6	—	1,602	36	1,357	11·7
Lincoln	14,994	12,448	7	—	1,694	171	674	5·6
Middlesex (ex.-metropol.)	11,321	9,753	24	—	976	60	508	5·0
Monmouth	7,901	7,026	4	—	594	54	223	3·5
Norfolk	13,924	11,888	7	—	1,547	72	410	3·5
Northampton	9,380	7,854	13	—	1,063	45	405	4·8
Northumberland	15,207	13,065	23	—	1,540	150	429	3·8
Nottingham	15,658	12,844	23	—	1,898	91	802	5·7
Oxford	5,725	4,886	6	—	561	54	218	4·8
Rutland	692	614	—	—	62	4	12	2·3
Salop	7,752	6,820	4	—	681	72	175	3·2
Somerset	15,080	13,218	4	—	1,341	139	329	3·1
Southampton	17,875	15,698	22	—	1,526	124	505	3·5
Stafford	32,422	27,857	22	—	3,413	112	1,018	3·5
Suffolk	11,329	9,945	2	1	1,036	98	247	3·0
Surrey (extra-metropol.)	13,904	12,083	10	1	1,178	132	500	4·5
Sussex	14,940	13,059	23	2	1,233	151	472	4·2
Warwick	25,455	21,900	30	—	2,575	102	848	3·7
Westmoreland	1,994	1,840	2	—	120	19	13	1·6
Wilts	7,610	6,838	3	—	595	56	118	2·3
Worcester	18,699	16,117	8	—	1,872	146	556	3·8
York, East Riding	12,408	10,285	11	—	1,449	84	579	5·3
York, North Riding	11,499	9,779	8	—	1,277	118	317	3·8
York, West Riding	76,428	62,520	80	—	8,480	561	4,787	7·0
Wales.								
Anglesey	1,019	879	—	—	94	10	36	4·5
Brecknock	1,625	1,403	—	—	171	6	45	3·1
Cardigan	2,090	1,845	—	—	178	26	41	3·2
Carmarthen	4,234	3,796	—	—	379	15	44	1·4
Carnarvon	3,645	3,221	4	—	316	41	63	2·9
Denbigh	2,705	2,394	—	—	252	17	42	2·2
Flint	2,733	2,478	—	—	233	19	53	2·6
Glamorgan	18,345	15,816	7	—	1,699	121	681	4·4
Merioneth	2,155	1,831	1	—	239	39	45	3·9
Montgomery	2,202	1,858	—	—	206	45	93	6·3
Pembroke	2,604	2,267	—	—	239	54	44	3·8
Radnor	554	479	—	—	56	8	11	3·4

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APP. A. No. 1.

Digest of Vaccination Officers' Returns.

METROPOLITAN UNIONS.	RETURNS, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
Bethnal Green - -	5,209	4,352	6	5	517	10	319	6·3
Camberwell - - -	6,681	5,614	9	—	585	17	456	7·1
Chelsea - - -	3,234	2,768	9	—	271	—	186	5·8
Fulham - - -	4,231	3,592	12	1	373	11	242	6·0
George, St., Hanover Sq. -	3,930	3,365	16	—	360	1	188	4·8
George, St., in the East -	1,871	1,566	3	—	171	2	129	7·0
Giles and George, S.S. -	1,513	1,226	—	—	132	6	149	10·2
Greenwich - - -	4,710	4,004	6	5	403	17	275	6·2
Hackney - - -	6,421	5,374	22	7	627	24	367	6·1
Hampstead - - -	1,108	976	3	—	94	7	28	3·2
Holborn - - -	5,714	4,769	3	2	551	19	370	6·8
Islington - - -	9,931	8,123	26	—	885	118	779	9·0
Kensington - - -	4,652	4,064	17	—	408	4	159	3·5
Lambeth - - -	9,296	7,292	28	3	845	66	1,062	12·1
Lewisham - - -	2,105	1,862	9	—	169	10	55	3·1
London, City - -	1,087	960	2	—	92	—	33	3·0
Marylebone - - -	5,133	4,183	9	1	557	33	350	7·5
Mile End Old Town -	4,185	3,480	14	2	388	16	285	7·2
Olave, St. - - -	5,422	4,772	6	1	373	26	244	5·0
Paddington - - -	2,873	2,380	7	—	267	42	170	7·6
Pancras, St. - -	8,113	6,839	16	2	668	12	576	7·2
Poplar - - -	6,251	5,440	7	1	562	6	235	3·9
Saviour, St. - - -	7,531	6,194	4	—	727	62	544	8·0
Shoreditch - - -	5,173	4,034	—	5	501	—	633	12·2
Stepney - - -	2,210	1,769	3	—	224	—	214	9·7
Strand - - -	902	736	—	—	83	10	73	9·2
Wandsworth and Clapham	7,092	6,085	20	—	629	43	315	5·0
Westminster - -	1,274	1,063	—	—	135	8	68	6·0
Whitechapel - -	2,673	2,400	—	—	212	2	59	2·3
Woolwich - - -	2,781	2,368	6	—	230	—	177	6·4
	133,306	111,650	263	35	12,039	579	8,740	7·0

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—	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed
BEDFORD.								
Ampthill	529	459	—	—	65	—	5	0·9
Bedford	1,285	1,117	1	—	119	4	44	3·7
Biggleswade	932	808	—	—	115	1	8	1·0
Leighton Buzzard	617	519	1	—	79	5	13	2·9
Luton	1,541	1,057	2	—	205	23	54	5·7
Woburn	305	262	1	—	35	1	6	2·3
BERKS.								
Abingdon	694	610	—	—	65	4	15	2·7
Bradfield	582	523	1	—	53	—	5	0·9
Cookham	529	479	—	—	34	4	12	3·0
Easthampstead	347	319	—	—	25	—	3	0·9
Faringdon	417	384	—	—	25	3	5	1·9
Hungerford	520	479	—	—	36	2	3	1·0
Newbury	606	507	2	—	56	29	12	6·8
Reading	1,581	1,360	—	—	172	21	28	3·1
Wallingford	392	352	—	—	30	4	6	2·6
Wantage	528	480	2	—	55	—	11	2·1
Windsor	926	802	1	—	90	1	32	3·6
Wokingham	654	578	—	—	41	7	28	5·4
BUCKS.								
Amersham	578	510	—	—	59	6	3	1·6
Aylesbury	758	641	—	—	76	15	26	5·4
Buckingham	348	291	1	—	46	2	8	2·9
Eton	729	653	—	—	70	2	4	0·8
Newport Pagnell	812	713	1	—	79	1	18	2·3
Winslow	228	204	—	—	21	2	1	1·3
Wycombe	1,419	1,241	1	—	148	7	22	2·0
CAMBRIDGE.								
Cambridge	1,040	903	2	—	111	4	20	2·3
Caxton and Arrington	328	288	—	—	30	—	10	3·0
Chesterton	904	806	—	—	69	1	28	3·2
Ely	600	491	—	—	75	12	22	5·7
Linton	397	353	—	—	32	—	12	3·0
Newmarket	874	761	—	—	103	1	9	1·1
North Witchford	475	413	1	—	56	1	4	1·1
Whittlesey	194	165	—	—	26	1	2	1·5
Wisbech	1,033	894	2	—	110	6	20	2·5
CHESTER.								
Altrincham	1,789	1,593	1	—	148	8	37	2·5
Birkenhead	3,661	3,289	7	—	296	5	64	1·9
Chester	1,601	1,402	1	—	155	8	35	2·7
Congleton	1,298	1,131	—	—	132	14	21	2·7
Macclesfield	1,875	1,569	3	—	213	20	70	4·8
Nantwich	2,061	1,635	2	—	223	12	189	9·8
Northwich	1,682	1,503	—	—	161	3	15	1·1
Runcorn	1,249	1,148	1	—	92	1	7	0·6
Stockport	3,862	3,258	4	4	415	25	156	4·7
Tarvin	346	311	1	—	24	4	6	2·9
Wirrall	880	805	2	—	48	8	17	2·8

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App. A. No. 1.

Digest of Vaccination Officers' Returns.

	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
CORNWALL.								
Austell, St.	940	816	—	—	110	3	11	1·5
Bodmin	519	459	2	—	50	2	6	1·5
Camelford	228	201	—	—	20	2	5	3·1
Columb, St., Major	489	438	—	—	46	—	5	1·0
Falmouth	694	591	—	—	81	5	17	3·2
Germans, St.	490	440	—	—	44	2	4	1·2
Helston	701	554	—	—	106	10	31	5·8
Launceston	465	426	—	—	31	4	4	1·7
Liskeard	815	712	1	—	73	11	18	3·6
Penzance	1,558	1,286	—	—	239	7	26	2·1
Redruth	1,365	1,083	—	—	238	10	34	3·2
Stratton	259	232	—	—	24	2	1	1·2
Truro	946	802	—	—	103	10	31	4·3
CUMBERLAND.								
Alston-with-Garrigill	111	103	—	—	7	—	1	0·9
Bootle	428	388	—	—	33	2	5	1·6
Brampton	303	269	—	—	27	2	5	2·3
Carlisle	1,756	1,556	—	—	159	6	35	2·3
Cockermouth	2,065	1,765	—	—	195	37	68	5·1
Longtown	213	197	—	—	12	3	1	1·9
Penrith	715	662	—	—	44	3	6	1·3
Whitehaven	2,210	1,901	5	—	226	15	63	3·5
Wigton	707	638	—	—	53	6	10	2·3
DERBY.								
Ashbourne	562	496	—	—	39	8	19	4·8
Bakewell	986	838	1	—	102	10	35	4·6
Belper	2,098	1,851	4	—	184	1	58	2·8
Chapel-en-le-Frith	601	502	1	—	63	7	28	5·8
Chesterfield	4,105	3,539	4	—	407	18	137	3·8
Derby	2,858	2,207	2	—	342	10	297	10·7
Glossop	737	631	—	—	72	5	29	4·6
Hayfield	379	336	—	—	31	6	6	3·2
Shardlow	1,643	1,417	2	—	171	3	50	3·2
DEVON.								
Axminster	507	445	1	—	49	—	12	2·4
Barnstaple	1,085	962	—	—	97	13	13	2·4
Bideford	571	505	1	—	51	4	10	2·5
Crediton	521	465	—	—	48	1	7	1·5
East Stonehouse	615	522	—	—	65	10	18	4·6
Exeter	1,166	974	—	—	143	15	34	4·2
Holsworthy	274	250	—	—	16	4	4	2·9
Honiton	688	624	—	—	57	1	6	1·0
Kingsbridge	549	488	—	—	53	2	6	1·5
Newton Abbot	2,103	1,897	3	—	175	5	23	1·3
Okehampton	483	433	—	—	32	11	7	3·7
Plymouth	2,382	1,899	2	—	285	24	172	8·2
Plympton St. Mary	684	604	—	—	49	12	19	4·5
South Molton	463	429	2	—	22	4	6	2·2
Stoke Damerel	1,534	1,355	1	—	122	6	50	3·7
Tavistock	787	720	—	—	64	1	2	0·4
Thomas, St.	1,418	1,266	—	—	110	9	33	3·0
Tiverton	835	727	1	—	71	13	23	4·3
Torrington	425	385	—	—	25	7	8	3·5
Totnes	1,134	1,083	2	—	36	9	4	1·1

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	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
DORSET.								
Beaminster	334	301	—	—	28	1	4	1·5
Blandford	384	325	—	—	30	3	26	7·6
Bridport	475	427	—	—	40	3	5	1·7
Cerne	180	167	—	—	10	3	—	1·7
Dorchester	525	464	—	—	52	4	5	1·7
Poole	658	586	1	—	55	6	10	2·4
Shaftesbury	351	306	—	—	27	10	8	5·1
Sherborne	360	334	—	—	20	1	5	1·7
Sturminster	298	269	—	—	19	—	8	2·7
Wareham and Purbeck	518	463	—	—	38	4	13	3·3
Weymouth	885	780	2	—	77	11	15	2·9
Wimborne and Cranborne	543	484	—	—	38	6	15	3·9
DURHAM.								
Auckland	3,214	2,697	—	—	384	22	111	4·1
Chester-le-Street	1,758	1,524	—	—	180	8	46	3·1
Darlington	1,660	1,372	2	—	197	6	83	5·4
Durham	2,405	2,012	1	—	272	24	96	5·0
Easington	1,653	1,394	—	—	193	—	66	4·0
Gateshead	4,152	3,275	3	1	507	40	326	8·8
Hartlepool	1,935	1,690	—	—	204	19	22	2·1
Houghton-le-Spring	1,361	1,147	—	—	169	14	31	3·3
Lanchester	2,187	1,932	2	—	212	5	36	1·9
Sedgefield	565	479	—	—	63	2	21	4·1
South Shields	4,240	3,345	1	—	476	60	358	9·9
Stockton	1,885	1,505	1	—	212	20	147	8·9
Sunderland	5,064	4,251	—	—	543	71	199	5·3
Teesdale	600	505	—	—	69	3	23	4·3
Weardale	521	458	—	—	47	5	11	3·1
ESSEX.								
Billericay	536	475	—	2	41	—	18	3·4
Braintree	859	735	—	—	91	11	22	3·8
Chelmsford	1,009	911	—	—	81	7	10	1·7
Colchester	913	769	3	—	100	11	30	4·5
Dunmow	497	454	—	—	37	2	4	1·2
Epping	650	560	—	—	63	1	26	4·2
Halstead	458	400	—	—	48	1	9	2·2
Lexden and Winstree	716	662	—	—	46	4	4	1·2
Maldon	778	704	1	—	50	4	19	3·0
Ongar	305	275	—	—	16	5	9	4·6
Orsett	540	480	—	—	44	5	11	3·0
Rochford	823	723	1	—	76	8	15	2·8
Romford	1,332	1,148	2	—	117	13	52	4·9
Saffron Walden	517	469	—	—	39	2	7	1·7
Tendring	1,079	949	4	—	101	3	22	2·3
West Ham	7,522	6,362	12	—	662	32	454	6·5
GLOUCESTER.								
Barton Regis	5,708	5,048	9	—	473	11	167	3·1
Bristol	1,873	1,566	—	—	189	6	112	6·3
Cheltenham	1,362	1,039	—	—	159	42	122	12·0
Chipping Sodbury	520	456	—	—	49	6	9	2·9
Cirencester	602	520	2	—	63	1	16	2·8
Dursley	351	309	—	—	28	1	13	4·0
Gloucester	1,515	1,346	2	—	135	5	27	2·1
Newent	313	287	—	—	21	—	5	1·6
Northleach	268	236	—	—	20	2	10	4·5

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Digest of Vaccination Officers' Returns.

	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
GLOUCESTER—*cont.*								
Stow-on-the-Wold	275	252	—	—	17	—	6	2·2
Stroud	1,257	1,116	—	—	127	4	10	1·1
Tetbury	198	177	—	—	11	5	5	5·0
Tewkesbury	396	352	2	—	26	3	12	3·8
Thornbury	514	471	—	—	28	9	6	2·9
Westbury-on-Severn	824	712	—	—	65	2	45	5·7
Wheatenhurst	221	205	—	—	15	—	1	0·5
Winchcomb	282	242	—	—	31	2	7	3·2
HEREFORD.								
Bromyard	298	232	—	—	38	8	20	9·4
Dore	206	179	—	—	19	3	5	3·9
Hereford	1,029	894	1	—	90	7	37	4·3
Kington	375	327	—	—	34	1	13	3·7
Ledbury	335	293	—	—	28	3	12	4·5
Leominster	410	327	3	—	41	6	33	9·5
Ross	535	466	—	—	45	7	17	4·5
Weobley	232	207	—	—	19	1	5	2·6
HERTS.								
Albans, St.	774	677	1	—	77	3	16	2·5
Barnet	918	814	1	—	88	3	12	1·6
Berkhampstead	500	435	—	—	50	—	15	3·0
Bishop's Stortford	673	617	—	—	46	2	8	1·5
Buntingford	167	153	—	—	9	—	5	3·0
Hatfield	199	176	—	—	14	2	7	4·5
Hemel Hempstead	450	394	—	—	48	—	8	1·8
Hertford	470	429	—	—	33	2	6	1·7
Hitchin	906	838	—	—	63	—	5	0·6
Royston	575	518	—	—	44	6	7	2·4
Ware	548	494	—	—	40	—	14	2·6
Watford	907	811	1	—	81	2	12	1·5
Welwyn	85	78	—	—	5	—	2	2·4
HUNTINGDON.								
Huntingdon	580	505	—	—	63	3	9	2·1
Ives, St.	505	451	—	—	42	6	6	2·4
Neots, St.	473	424	—	—	34	9	6	3·2
KENT (Extra-Metropolitan).								
Ashford, East	418	381	—	—	32	1	4	1·2
Ashford, West	570	510	1	—	43	3	14	2·8
Bean	590	537	—	—	42	1	10	1·9
Bridge	374	339	1	—	23	—	11	2·9
Bromley	1,470	1,292	1	—	149	15	13	1·9
Canterbury	517	439	5	—	52	4	17	4·1
Cranbrook	423	381	1	—	37	3	1	1·0
Dartford	1,767	1,560	3	—	150	17	37	3·1
Dover	1,190	935	1	—	117	27	110	11·5
Eastry	772	684	—	—	52	5	31	4·7
Elham	1,080	950	1	—	97	9	23	3·0
Faversham	902	820	2	—	73	—	7	0·8
Gravesend and Milton	686	603	1	—	62	2	18	2·9
Hollingbourn	418	369	—	—	34	—	15	3·6
Hoo	122	103	—	—	13	6	—	4·9
Maidstone	1,462	1,253	—	—	135	23	46	5·1

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	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
KENT (EXTRA-METROPOLITAN)—*cont.*								
Malling	927	843	—	—	68	—	16	1·7
Medway	1,994	1,818	2	—	162	6	6	0·6
Milton	949	842	—	—	87	9	11	2·1
North Aylesford	991	879	—	—	109	1	2	0·3
Romney Marsh	215	205	—	—	8	1	1	0·9
Sevenoaks	782	710	3	—	51	2	16	2·3
Sheppey	635	557	—	—	61	6	11	2·7
Tenterden	309	289	—	—	12	—	8	2·6
Thanet, Isle of	1,489	1,358	2	—	117	8	24	2·1
Tonbridge	1,534	1,375	1	—	83	25	50	4·9
LANCASTER.								
Ashton-under-Lyne	5,350	4,556	4	—	563	35	192	4·2
Barrow-in-Furness	1,759	1,530	1	—	177	5	46	2·9
Barton-upon-Irwell	2,446	2,146	4	—	205	10	81	3·6
Blackburn	6,334	5,546	2	—	655	32	99	2·1
Bolton	7,000	6,392	1	—	552	1	54	0·8
Burnley	4,320	3,662	—	—	509	34	115	3·4
Bury	4,452	3,925	1	—	394	10	102	2·5
Chorley	1,738	1,468	—	—	177	—	93	5·4
Chorlton	9,082	7,352	5	—	1,049	50	626	7·4
Clitheroe	714	625	1	—	62	6	20	3·6
Fylde, The	1,395	1,184	—	—	158	2	51	3·8
Garstang	377	330	—	—	37	—	10	2·7
Haslingden	3,254	2,946	1	—	275	9	23	1·0
Lancaster	1,331	1,140	—	—	137	12	42	4·1
Leigh	2,289	1,983	3	—	242	10	51	2·7
Liverpool	7,300	6,083	4	—	857	7	349	4·9
Lunesdale	212	196	—	—	12	2	2	1·9
Manchester	5,637	4,526	1	—	621	29	460	8·7
Oldham	5,832	4,497	7	—	712	73	543	10·6
Ormskirk	2,759	2,574	—	—	296	11	88	3·6
Prescot	4,820	4,029	—	—	537	40	214	5·3
Preston	4,597	3,707	1	—	584	84	221	6·6
Prestwich	4,651	3,749	2	—	486	11	403	8·9
Rochdale	3,679	3,196	1	—	369	31	82	3·1
Salford	7,388	5,993	6	—	915	71	403	6·4
Todmorden	1,033	903	1	—	103	—	26	2·5
Torteth Park	4,489	3,750	15	—	441	28	255	6·3
Ulverston	1,499	1,343	2	—	117	16	21	2·5
Warrington	2,826	2,311	—	—	317	56	142	7·0
West Derby	13,516	11,248	17	—	1,566	147	538	5·1
Wigan	6,037	5,301	3	—	620	28	85	1·9
LEICESTER.								
Ashby-de-la-Zouch	1,236	1,091	—	—	102	—	43	3·5
Barrow-on-Soar	1,003	806	—	—	155	7	125	12·4
Billesdon	271	224	—	—	19	—	28	10·3
Blaby	823	658	—	—	102	5	58	7·7
Hinckley	651	554	—	—	93	—	4	0·6
Leicester	4,860	3,010	5	—	816	14	1,015	21·2
Loughborough	985	834	—	—	120	3	28	3·1
Lutterworth	354	312	—	—	28	—	14	4·0
Market Bosworth	524	461	—	—	50	3	10	2·5
Market Harborough	469	406	1	—	51	3	8	2·3
Melton Mowbray	644	553	—	—	66	1	24	3·9

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LINCOLN.								
Boston	1,180	960	—	—	135	2	83	7·2
Bourn	561	485	—	—	56	6	14	3·6
Caistor	2,403	2,017	—	—	260	22	104	5·2
Gainsborough	1,027	796	1	—	129	34	65	9·6
Glanford Brigg	1,373	1,180	2	—	157	2	32	2·5
Grantham	1,108	941	3	—	113	10	41	4·6
Holbeach	670	574	—	—	63	8	25	4·9
Horncastle	658	572	—	—	70	2	14	2·4
Lincoln	2,111	1,592	1	—	303	55	160	10·2
Louth	1,034	881	—	—	110	8	35	4·2
Sleaford	748	659	—	—	79	—	10	1·3
Spalding	726	626	—	—	71	10	19	4·6
Spilsby	843	688	—	—	87	11	57	8·1
Stamford	552	475	—	—	61	1	15	2·9
MIDDLESEX (Extra-Metropolitan).								
Brentford	3,415	2,919	6	—	296	13	181	5·7
Edmonton	4,650	4,009	13	—	391	23	214	5·1
Hendon	1,744	1,483	5	—	166	14	76	5·2
Staines	684	593	—	—	52	6	33	5·7
Uxbridge	828	749	—	—	71	4	4	1·0
MONMOUTH.								
Abergavenny	719	648	—	—	58	3	10	1·8
Bedwelty	1,975	1,758	—	—	152	14	51	3·3
Chepstow	531	474	—	—	37	4	16	3·8
Monmouth	944	834	1	—	77	9	23	3·4
Newport	2,538	2,296	3	—	183	16	40	2·2
Pontypool	1,194	1,016	—	—	87	8	83	7·6
NORFOLK.								
Aylsham	559	364	—	—	50	8	137	25·9
Blofield	340	309	—	—	27	1	3	1·2
Depwade	718	615	2	—	68	4	29	4·6
Docking	533	468	—	—	58	2	5	1·3
Downham	616	537	—	—	71	—	8	1·3
Erpingham	597	531	—	—	58	3	5	1·3
Faith, St.	385	338	2	—	39	1	5	1·6
Flegg, East and West	370	290	—	—	58	2	11	3·5
Forehoe	332	291	—	—	29	1	11	3·6
Freebridge Lynn	440	372	—	—	47	6	15	4·8
Guiltcross	326	272	—	—	39	2	13	4·6
Henstead	317	284	2	—	25	—	6	1·9
King's Lynn	530	495	—	—	68	3	14	2·9
Loddon and Clavering	420	377	—	—	36	2	5	1·7
Mitford and Launditch	841	760	—	—	72	4	5	1·1
Norwich	2,976	2,496	1	—	413	3	63	2·1
Swaffham	377	317	—	—	49	4	7	2·9
Thetford	554	475	—	—	54	2	23	4·5
Smallburgh	456	399	—	—	49	1	7	1·8
Walsingham	614	528	—	—	65	4	17	3·4
Wayland	383	330	—	—	32	6	5	3·2
Yarmouth, Great	1,230	1,061	—	—	140	13	16	2·4

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	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
NORTHAMPTON.								
Brackley	331	255	2	—	44	9	21	9·1
Brixworth	391	348	—	—	33	—	10	2·6
Daventry	532	463	2	—	58	—	9	1·7
Hardingstone	357	307	1	—	39	—	10	2·8
Kettering	906	764	3	—	103	6	30	4·0
Northampton	2,347	1,774	3	—	334	8	228	10·1
Oundle	401	355	—	—	40	—	6	1·5
Peterborough	1,490	1,326	—	—	135	—	29	1·9
Potterspury	411	361	—	—	41	2	7	2·2
Thrapston	538	467	—	—	60	3	8	2·0
Towcester	406	356	1	—	42	3	6	2·2
Wellingborough	1,268	1,078	1	—	134	14	41	4·3
NORTHUMBERLAND.								
Alnwick	612	536	—	—	41	24	11	5·7
Belford	155	137	4	—	14	—	—	0·0
Bellingham	144	129	—	—	10	—	5	3·5
Berwick-on-Tweed	651	572	1	—	63	6	9	2·3
Castle Ward	636	524	1	—	66	3	42	7·1
Glendale	258	225	1	—	27	—	5	1·9
Haltwhistle	258	232	—	—	22	4	—	1·6
Hexham	1,077	925	—	—	93	5	54	5·5
Morpeth	1,423	1,233	2	—	160	2	26	2·0
Newcastle-on-Tyne	5,540	4,807	8	—	557	37	131	3·0
Rothbury	168	150	—	—	12	—	6	3·6
Tynemouth	4,285	3,595	6	—	475	69	140	4·9
NOTTINGHAM.								
Basford	4,758	3,979	8	—	576	23	173	4·1
Bingham	446	377	1	—	63	1	4	1·1
East Retford	721	655	—	—	53	1	12	1·8
Mansfield	1,783	1,447	1	—	238	14	83	5·4
Newark	1,013	882	2	—	96	4	29	3·3
Nottingham	5,339	4,091	11	—	721	43	473	9·7
Southwell	565	495	—	—	52	1	17	3·2
Worksop	1,053	918	—	—	99	5	11	1·5
OXFORD.								
Banbury	912	676	1	—	92	18	125	15·7
Bicester	404	350	—	—	43	5	6	2·7
Chipping Norton	604	519	—	—	62	9	14	3·8
Headington	935	820	—	—	96	5	14	2·0
Henley	615	547	—	—	52	1	15	2·6
Oxford	727	633	4	—	73	6	22	3·9
Thame	443	389	—	—	43	1	10	2·5
Witney	680	615	—	—	54	6	5	1·6
Woodstock	405	347	1	—	47	3	7	2·5
RUTLAND.								
Oakham	321	284	—	—	31	1	5	1·9
Uppingham	371	330	—	—	31	3	7	2·7

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Digest of Vaccination Officers' Returns.

	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
SALOP.								
Atcham	1,307	1,154	1	—	109	23	20	3·3
Bridgnorth	427	382	—	—	26	2	17	4·4
Church Stretton	137	125	—	—	8	—	4	2·9
Cleobury Mortimer	221	203	—	—	15	1	2	1·4
Clun	292	238	—	—	34	9	11	6·8
Drayton	395	360	—	—	30	5	—	1·3
Ellesmere	383	340	—	—	35	—	8	2·1
Ludlow	543	456	1	—	55	5	26	5·7
Madeley	844	743	1	—	74	4	22	3·1
Newport	446	395	—	—	39	2	10	2·7
Oswestry	844	751	—	—	77	2	14	1·9
Shifnal	373	316	—	—	37	6	14	5·4
Wellington	926	801	—	—	100	7	18	2·7
Wem	258	240	1	—	13	3	1	1·6
Whitchurch	356	316	—	—	29	3	8	3·1
SOMERSET.								
Axbridge	1,164	1,025	1	—	95	14	29	3·7
Bath	1,837	1,501	—	—	218	37	81	6·4
Bedminster	2,499	2,191	1	—	254	17	36	2·1
Bridgwater	1,032	906	1	—	88	3	34	3·6
Chard	846	741	—	—	84	6	15	2·5
Clutton	817	738	—	—	70	—	9	1·1
Dulverton	144	138	—	—	5	—	1	0·7
Frome	692	636	—	—	43	—	13	1·9
Keynsham	906	805	—	—	75	4	22	2·9
Langport	447	400	—	—	32	4	11	3·4
Shepton Mallet	474	429	—	—	35	4	6	2·1
Taunton	1,035	923	1	—	90	11	10	2·0
Wellington	576	527	—	—	46	1	2	0·5
Wells	632	548	—	—	51	14	19	5·2
Williton	523	480	—	—	33	3	7	1·9
Wincanton	553	488	—	—	53	—	12	2·2
Yeovil	853	742	—	—	69	20	22	4·8
SOUTHAMPTON.								
Alresford	185	165	—	—	14	2	4	3·2
Alton	495	443	—	—	36	2	14	3·2
Alverstoke	700	637	1	—	60	—	2	0·3
Andover	427	373	—	—	39	5	10	3·5
Basingstoke	625	543	—	—	47	17	18	5·6
Catherington	73	59	—	—	4	1	9	13·7
Christchurch	846	727	2	—	75	13	29	5·0
Droxford	322	296	—	—	19	2	5	2·2
Fareham	439	397	—	—	27	—	15	3·4
Fordingbridge	155	137	—	—	17	—	1	0·6
Hartley Wintney	549	488	—	—	34	2	25	4·9
Havant	281	257	—	—	16	2	6	2·8
Hursley	82	72	—	—	8	1	1	2·4
Kingsclere	239	216	—	—	20	2	1	1·3
Lymington	382	329	—	—	33	—	20	5·2
New Forest	345	304	1	—	28	1	11	3·5
Petersfield	315	293	—	—	18	1	3	1·3
Portsea Island	4,420	3,930	11	—	379	19	81	2·3
Ringwood	136	127	—	—	7	—	2	1·5
Romsey	359	307	—	—	38	2	12	3·9
Southampton	1,748	1,430	3	—	196	18	101	6·8
South Stoneham	1,320	1,128	1	—	125	20	46	5·0
Stockbridge	203	176	—	—	21	2	4	3·0
Whitchurch	176	154	—	—	10	5	7	6·8
Wight, Isle of	2,150	1,896	2	—	176	5	71	3·5
Winchester, New	903	814	1	—	79	2	7	1·0

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	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-Pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
STAFFORD.								
Wolstanton and Burslem	3,007	2,586	—	—	302	6	23	1·0
Burton-on-Trent	2,916	2,445	1	—	259	21	190	7·2
Cannock	1,342	1,149	—	—	143	4	46	3·7
Cheadle	740	673	1	—	56	4	6	1·4
Leek	1,100	948	1	—	109	13	29	3·8
Lichfield	1,230	1,074	5	—	114	6	31	3·0
Newcastle-under-Lyme	1,273	1,083	—	—	116	2	72	5·8
Seisdon	485	430	1	—	43	—	11	2·3
Stafford	938	816	4	—	86	8	24	3·4
Stoke-upon-Trent	4,170	3,448	—	—	537	16	169	4·4
Stone	935	808	1	—	100	2	24	2·8
Tamworth	726	618	—	—	75	5	28	4·6
Uttoxeter	416	390	—	—	19	—	7	1·7
Walsall	3,285	2,809	3	—	359	6	108	3·5
West Bromwich	4,938	4,359	3	—	472	14	90	2·1
Wolverhampton	4,921	4,231	2	—	533	5	160	3·4
SUFFOLK.								
Blything	824	743	—	—	61	4	16	2·4
Bosmere and Claydon	499	429	1	—	42	—	27	5·4
Bury St. Edmunds	500	423	—	—	62	3	12	3·0
Cosford	489	441	—	—	43	—	5	1·0
Hartismere	507	460	—	—	38	1	8	1·8
Hoxne	401	362	—	—	32	1	6	1·7
Ipswich	1,632	1,346	1	1	179	39	64	6·3
Mildenhall	300	264	—	—	24	—	12	4·0
Mutford and Lothingland	1,468	1,295	—	—	147	9	17	1·8
Plomesgate	588	511	—	—	56	6	15	3·6
Risbridge	578	522	—	—	47	2	7	1·6
Samford	378	334	—	—	32	3	9	3·2
Stow	656	581	—	—	63	4	8	1·8
Sudbury	852	749	—	—	64	17	22	4·6
Thingoe	507	446	—	—	49	6	6	2·4
Wangford	435	396	—	—	38	—	4	0·9
Woodbridge	715	644	—	—	59	3	9	1·7
SURREY (Extra-Metropolitan).								
Chertsey	849	735	—	—	62	24	28	6·1
Croydon	3,629	2,959	3	—	343	49	275	8·9
Dorking	466	434	—	—	26	—	6	1·3
Epsom	1,115	915	1	—	121	25	53	7·0
Farnham	1,505	1,303	3	—	138	8	53	4·1
Godstone	421	372	—	—	30	1	18	4·5
Guildford	1,216	1,105	—	—	92	6	13	1·6
Hambledon	464	425	—	—	32	2	5	1·5
Kingston	2,329	2,107	2	—	183	13	24	1·6
Reigate	901	816	—	—	71	4	10	1·6
Richmond	1,099	912	1	1	80	—	15	1·5
SUSSEX.								
Battle	453	393	—	—	45	5	10	3·3
Brighton	2,912	2,535	4	1	265	23	85	3·7
Chailey	286	251	—	—	24	5	6	3·8
Chichester	254	206	1	—	29	5	13	7·1
Cuckfield	748	650	—	—	57	10	31	5·5
Eastbourne	829	711	2	—	76	9	31	4·8
East Grinstead	604	518	1	—	48	7	30	6·1
East Preston	745	658	—	—	68	4	15	2·6

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App. A. No. 1.

Digest of Vaccination Officers' Returns.

	Returns, 1890.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
SUSSEX—*cont.*								
Hailsham	440	392	—	—	30	6	12	4·1
Hastings	1,375	1,110	—	—	144	35	86	8·8
Horsham	676	609	4	—	44	2	17	2·8
Lewes	346	290	1	—	33	9	13	6·4
Midhurst	422	391	—	—	24	3	4	1·7
Newhaven	276	226	1	—	25	1	23	8·7
Petworth	267	248	—	—	12	6	1	2·6
Rye	410	364	3	—	37	—	6	1·5
Steyning	1,525	1,561	2	1	117	5	38	2·8
Thakeham	267	243	—	—	15	9	—	3·4
Ticehurst	521	475	1	—	29	2	14	3·1
Uckfield	706	633	2	—	46	1	24	3·5
Westbourne	234	214	—	—	13	2	5	3·0
West Firle	65	58	—	—	5	1	1	3·1
Westhampnett	580	523	1	—	47	2	7	1·6
WARWICK.								
Alcester	619	527	—	—	66	7	19	4·2
Aston	8,372	7,009	11	—	850	44	458	6·0
Atherstone	514	458	1	—	45	—	10	1·9
Birmingham	9,225	8,015	10	—	967	19	214	2·5
Coventry	1,432	1,226	2	—	170	6	28	2·4
Foleshill	652	578	—	—	66	6	2	1·2
Meriden	278	252	—	—	16	5	5	3·6
Nuneaton	488	414	—	—	67	5	12	3·4
Rugby	871	753	—	—	84	—	34	3·9
Solihull	563	497	—	—	46	5	15	3·6
Southam	308	274	—	—	29	2	3	1·6
Stratford-on-Avon	670	594	1	—	50	—	25	3·7
Warwick	1,453	1,303	5	—	119	3	23	1·8
WESTMORELAND.								
East Ward	446	411	—	—	28	5	2	1·6
Kendal	1,315	1,209	2	—	82	13	9	1·7
West Ward	233	220	—	—	10	1	2	1·3
WILTS.								
Alderbury	777	696	—	—	69	3	9	1·5
Amesbury	203	186	—	—	16	—	1	0·5
Bradford	315	291	—	—	21	—	3	1·0
Calne	237	223	—	—	9	4	1	2·1
Chippenham	648	596	1	—	40	4	7	1·7
Cricklade and Wootton Bassett.	358	306	2	—	35	6	9	4·2
Devizes	594	530	—	—	48	5	11	2·7
Highworth and Swindon	1,399	1,211	—	—	137	14	37	3·6
Malmesbury	425	377	—	—	32	9	7	3·8
Marlborough	283	248	—	—	8	—	7	2·7
Melksham	543	490	—	—	46	1	6	1·3
Mere	194	176	—	—	17	1	—	0·5
Pewsey	361	332	—	—	20	2	7	2·5
Tisbury	258	231	—	—	25	1	1	0·8
Warminster	411	375	—	—	23	5	8	3·2
Westbury and Whorwelsdown.	329	296	—	—	30	1	2	0·9
Wilton	295	274	—	—	19	—	2	0·7

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	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
WORCESTER.								
Bromsgrove	1,033	901	1	—	108	8	15	2·2
Droitwich	825	721	—	—	75	5	24	3·5
Dudley	5,779	5,028	3	—	607	35	106	2·4
Evesham	411	367	—	—	24	4	16	4·9
Kidderminster	1,382	1,219	—	—	134	9	20	2·1
King's Norton	3,041	2,511	2	—	309	31	188	7·2
Martley	438	384	—	—	40	3	11	3·2
Pershore	416	368	—	—	44	—	4	1·0
Shipston-on-Stour	511	446	1	—	47	3	14	3·3
Stourbridge	3,055	2,651	—	—	294	19	91	3·6
Tenbury	221	187	—	—	18	8	8	7·2
Upton-on-Severn	561	505	1	—	42	5	8	2·3
Worcester	1,026	829	—	—	130	16	51	6·5
YORK, East Riding.								
Beverley	743	628	—	—	77	11	27	5·1
Bridlington	552	468	1	—	65	6	12	3·3
Driffield	699	576	—	—	102	5	16	3·0
Howden	397	348	—	—	39	1	9	2·5
Kingston-upon-Hull	2,830	2,371	5	—	340	15	99	4·0
Patrington	279	243	—	—	23	—	13	4·7
Pocklington	487	405	2	—	63	8	9	3·5
Sculcoates	3,657	3,057	3	—	410	17	170	4·1
Skirlaugh	307	259	—	—	38	—	10	3·3
York	2,457	1,930	—	—	292	21	214	9·6
YORK, North Riding.								
Aysgarth	184	161	1	—	18	2	2	2·2
Bedale	247	219	—	—	24	2	2	1·6
Easingwold	282	243	—	—	31	1	7	2·8
Guisborough	1,640	1,396	—	—	197	6	41	2·9
Helmsley Blackmoor	181	163	—	—	16	—	2	1·1
Kirkby Moorside	150	130	—	—	17	2	1	2·0
Leyburn	215	193	—	—	18	1	3	1·9
Malton	754	593	3	—	99	22	37	7·8
Middlesbrough	3,454	2,910	2	—	432	29	81	3·2
Northallerton	379	335	—	—	31	3	10	3·4
Pickering	349	293	1	—	34	3	18	6·0
Reeth	139	123	—	—	13	1	2	2·2
Richmond	416	375	—	—	32	2	7	2·2
Scarborough	1,427	1,168	—	—	166	29	64	6·5
Stokesley	359	311	—	—	36	4	8	3·3
Thirsk	422	361	1	—	45	3	12	3·6
Whitby	901	805	—	—	68	8	20	3·1
YORK, West Riding.								
Barnsley	3,342	2,668	—	—	425	53	196	7·5
Bramley	2,021	1,738	—	—	217	20	46	3·3
Bradford	6,416	5,057	4	—	780	13	562	9·0
Bierley, North	4,188	3,478	6	—	457	39	208	5·9
Dewsbury	5,379	3,754	9	—	713	82	821	16·8
Doncaster	1,943	1,669	—	—	224	10	40	2·6
Ecclesall Bierlow	4,068	3,488	7	—	394	17	162	4·4
Goole	712	626	1	—	69	1	15	2·2
Halifax	5,517	4,710	5	—	584	53	165	4·0

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App. A. No. 1.

Digest of Vaccination Officers' Returns.

	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
YORK, West Riding—*cont.*								
Hemsworth	350	311	—	—	26	2	11	3·7
Holbeck	894	779	1	—	92	5	17	2·5
Huddersfield	4,843	4,301	2	—	488	8	44	1·1
Hunslet	2,430	1,959	3	—	310	55	103	6·5
Keighley	1,382	465	1	—	222	24	1,170	63·4
Knaresborough	678	549	3	—	84	8	34	6·2
Leeds	6,775	6,033	4	—	663	2	73	1·1
Ouseburn, Great	361	319	2	—	37	—	3	0·8
Pateley Bridge	276	254	1	—	17	1	3	1·4
Penistone	651	548	2	—	80	12	9	3·2
Pontefract	1,955	1,626	1	—	225	1	102	5·3
Ripon	458	390	—	—	36	8	24	7·0
Rotherham	2,999	2,501	4	—	358	25	111	4·5
Saddleworth	664	575	—	—	62	—	27	4·1
Sedbergh	128	119	—	—	8	1	—	0·8
Selby	531	470	—	—	52	5	4	1·7
Settle	442	396	—	—	35	5	6	2·5
Sheffield	7,225	5,970	5	—	871	20	359	5·2
Skipton	1,198	981	10	—	135	12	60	6·0
Tadcaster	843	701	—	—	93	3	46	5·8
Thorne	510	432	—	—	56	5	17	4·3
Wakefield	3,482	2,953	3	—	328	19	179	5·7
Wetherby	436	336	1	—	46	15	38	12·2
Wharfedale	1,512	1,238	2	—	169	26	77	6·8
Wortley	1,319	1,126	3	—	124	11	55	5·0
ANGLESEY.								
Anglesey	404	355	—	—	34	3	12	3·7
Holyhead	615	524	—	—	60	7	24	5·6
BRECKNOCK.								
Brecknock	493	436	—	—	48	—	11	2·2
Builth	230	206	—	—	19	1	4	2·2
Crickhowell	596	485	—	—	79	2	30	5·4
Hay	304	276	—	—	25	3	—	1·0
CARDIGAN.								
Aberaeron	352	312	—	—	31	1	8	2·6
Aberystwith	678	572	—	—	67	19	20	5·8
Cardigan	455	423	—	—	29	2	1	0·7
Lampeter	307	274	—	—	23	4	6	3·3
Tregaron	298	264	—	—	28	—	6	2·0
CARMARTHEN.								
Carmarthen	1,051	938	—	—	105	—	8	0·8
Llanelly	1,656	1,482	—	—	142	9	23	1·9
Llandilo Fawr	544	480	—	—	56	2	6	1·5
Llandovery	450	395	—	—	46	4	5	2·0
Newcastle-in-Emlyn	533	501	—	—	30	—	2	0·4

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	Returns, 1880.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Dead. Unvaccinated.	Vaccination postponed.	Remaining.	Per-centage of Children not finally accounted for, including Cases postponed.
CARNARVON.								
Bangor and Beaumaris	1,087	978	—	—	90	4	15	1·7
Carnarvon	1,413	1,237	3	—	135	19	19	2·7
Conway	511	440	1	—	40	6	24	5·9
Pwllheli	634	566	—	—	51	12	5	2·7
DENBIGH.								
Llanrwst	407	362	—	—	34	7	4	2·7
Ruthin	392	357	—	—	33	1	1	0·5
Wrexham	1,906	1,675	—	—	185	9	37	2·4
FLINT.								
Asaph, St.	831	742	—	—	77	4	8	1·4
Hawarden	528	485	—	—	37	3	3	1·1
Holywell	1,424	1,251	—	—	119	12	42	3·8
GLAMORGAN.								
Bridgend and Cowbridge	1,215	1,041	—	—	105	7	62	5·7
Cardiff	3,626	2,938	6	—	380	9	296	8·3
Gower	354	327	—	—	17	4	6	2·8
Merthyr Tydfil	3,493	3,101	—	—	304	16	72	2·5
Neath	1,905	1,690	1	—	168	12	34	2·4
Pontardawe	701	630	—	—	57	6	8	2·0
Pontypridd	3,447	2,939	—	—	345	42	121	4·7
Swansea	3,604	3,180	—	—	314	25	85	3·1
MERIONETH.								
Bala	184	162	—	—	18	3	1	2·2
Corwen	502	418	1	—	53	5	25	6·0
Dolgelley	453	395	—	—	46	9	3	2·6
Festiniog	1,016	856	—	—	122	22	16	3·7
MONTGOMERY.								
Llanfyllin	554	493	—	—	37	13	11	4·3
Machynlleth	336	268	—	—	44	10	14	7·1
Forden	512	439	—	—	45	6	22	5·5
Newtown and Llanidloes	800	658	—	—	80	16	46	7·7
PEMBROKE.								
Haverfordwest	1,023	878	—	—	109	17	19	3·5
Narberth	566	518	—	—	37	14	19	5·6
Pembroke	993	871	—	—	93	23	6	2·9
RADNOR.								
Knighton	335	285	—	—	39	7	4	3·3
Rhayader	219	194	—	—	17	1	7	3·7

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App. A. No. 2.

Inspection of Public Vaccination.

No. 2.

List (alphabetically arranged) of 284 Unions inspected during the Year 1882, with reference to the Proceedings under the Vaccination Acts, 1867 and 1871, and an Account of the Awards made to the respective Public Vaccinators out of Moneys voted by Parliament for that Purpose.

Union.	No. of Vaccination Districts in the Union.	No. of respective Vaccination Contractors recommended for Award.		Range of Awards in each Union.		Total Sum awarded in the Union.	Inspector.
		1st Class Award.	2nd Class Award.	Minimum.	Maximum.		
				£ s. d.	£ s. d.	£ s. d.	
Abergavenny	3	3	—	6 12 0	27 17 0	59 9 0	Mr. Spear.
Abingdon	6	5	—	3 12 0	16 2 0	42 11 0	Dr. Stevens.
Alnwick	7	2	—	12 8 0	16 17 0	29 5 0	Mr. Power.
Alresford	2	2	—	6 8 0	7 8 0	13 16 0	Dr. Stevens.
Alton	4	3	—	5 1 0	11 18 0	24 5 0	Do.
Alverstoke	1	1	—	—	—	46 0 0	Do.
Amersham	6	3	—	8 9 0	23 0 0	40 10 0	„ Thorne.
Andover	5	5	—	1 10 0	14 15 0	35 13 0	„ Stevens.
Ashby-de-la-Zouch	6	2	—	15 8 0	22 6 0	37 14 0	„ Parsons.
Atcham	6	3	—	6 9 0	39 10 0	55 12 0	Do.
Axminster	12	2	—	6 13 6	7 12 0	14 4 0	„ Ballard.
Aylesbury	7	5	—	7 1 0	9 9 0	41 7 0	„ Thorne.
Aysgarth	2	—	—	—	—	—	Mr. Power.
Barnsley	5	5	—	19 9 0	83 4 0	238 19 0	Dr. Barry.
Barnstaple	10	7	1	0 4 0	20 8 0	49 14 8	„ Ballard.
Barrow-on-Soar	5	2	—	5 4 0	8 3 0	13 7 0	„ Parsons.
Barton Regis	6	6	—	17 10 0	75 18 0	226 16 0	„ Blaxall.
Basford	13	6	—	7 11 0	29 1 0	87 1 0	Do.
Basingstoke	6	6	—	0 8 0	13 18 0	36 2 0	„ Stevens.
Bath	5	2	1	3 9 4	8 15 0	17 12 4	„ Blaxall.
Bedale	3	3	—	3 12 0	13 18 0	23 0 0	Mr. Power.
Bedwelty	6	4	—	7 17 0	46 18 0	111 2 0	„ Spear.
Belford	2	—	—	—	—	—	„ Power.
Bellingham	6	—	—	—	—	—	Do.
Beverley	5	3	—	4 2 0	22 5 0	31 3 0	Mr. Spear.
Bideford	7	4	—	0 7 0	10 12 0	24 4 0	Dr. Ballard.
Billesdon	3	—	—	—	—	—	„ Parsons.
Bingham	4	3	—	4 18 0	10 7 0	21 6 0	„ Blaxall.
Birmingham	1	1	—	—	—	247 11 0	„ Stevens.
Blaby	3	—	—	—	—	—	„ Parsons.
Blofield	3	2	—	11 11 0	14 5 0	25 16 0	„ Airy.
Bourn	7	1	—	—	—	9 15 0	„ Parsons.
Bradfield	6	6	—	4 12 0	11 13 0	43 9 0	„ Stevens.
Bramley	5	2	—	41 0 0	42 15 0	83 15 0	„ Parsons.
Brentford	8	4	1	14 3 0	41 9 0	121 17 4	Mr. Power.
Bridgnorth	3	2	—	3 15 0	8 2 0	11 17 0	Dr. Parsons.
Bridlington	4	—	—	—	—	—	Mr. Spear.
Brixworth	6	3	—	2 12 0	9 13 0	18 12 0	Dr. Parsons.
Bromsgrove	5	4	—	1 9 0	27 13 0	54 19 0	Mr. Spear.
Bromyard	3	—	—	—	—	—	Do.
Buckingham	3	3	—	4 4 0	14 15 0	26 8 0	Dr. Thorne.
Burton-on-Trent	8	4	1	4 4 0	45 4 0	83 3 8	„ Parsons.
Cannock	6	1	—	—	—	8 4 0	Dr. Parsons.
Catherington	1	1	—	—	—	5 11 0	„ Stevens.
Cheadle	5	2	—	10 3 0	14 10 0	24 13 0	„ Parsons.
Cheltenham	3	—	—	—	—	—	„ Blaxall.
Chepstow	5	3	—	7 2 0	14 11 0	31 10 0	Mr. Spear.
Chertsey	5	4	—	3 3 0	15 12 0	35 5 0	Dr. Stevens.
Chipping Sodbury	5	2	—	2 9 0	2 17 0	5 6 0	„ Blaxall.
Christchurch	2	2	—	8 14 0	41 1 0	49 15 0	„ Stevens.
Church Stretton	4	2	—	3 9 0	4 4 0	7 13 0	„ Parsons.

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UNION.	No. of Vaccination Districts in the Union.	No. of respective Vaccination Contractors recommended for Award.		Range of Awards in each Union.		Total Sum awarded in the Union.	Inspector.
		1st Class Award.	2nd Class Award.	Minimum.	Maximum.		
				£ s. d.	£ s. d.	£ s. d.	
Cirencester	4	1	—	—	—	8 1 0	Dr. Blaxall.
Cleobury Mortimer	2	—	—	—	—	—	„ Parsons.
Clitheroe	5	5	—	5 1 0	34 7 0	67 8 0	Mr. Spear.
Clun	4	1	—	—	—	5 18 0	Dr. Parsons.
Cookham	4	1	—	—	—	17 6 0	„ Stevens.
Coventry	1	1	—	—	—	90 17 0	Do.
Crediton	11	2	1	0 4 8	3 15 0	7 10 8	„ Ballard.
Croydon	7	6	—	4 16 0	84 0 0	155 2 0	„ Stevens.
Darlington	5	2	—	6 1 0	55 7 0	61 8 0	Mr. Spear.
Daventry	6	2	—	6 8 0	6 17 0	13 5 0	Dr. Parsons.
Doncaster	7	5	—	7 17 0	51 6 0	120 5 0	„ Barry.
Dore	3	3	—	3 19 0	6 10 0	16 10 0	Mr. Spear.
Dorking	4	4	—	1 14 0	9 16 0	29 15 0	Dr. Stevens.
Drayton	5	1	1	1 16 0	9 16 0	11 12 0	„ Parsons.
Driffield	8	4	—	3 1 0	17 14 0	32 18 0	Mr. Spear.
Droitwich	6	5	—	1 9 0	22 3 0	45 5 0	Do.
Droxford	4	3	—	5 17 0	7 16 0	20 14 0	Dr. Stevens.
Dudley	8	6	1	16 10 8	63 6 0	254 0 8	Mr. Spear.
Dursley	3	1	—	—	—	8 15 0	Dr. Blaxall.
Easingwold	4	1	—	—	—	9 15 0	Mr. Power.
East Hampstead	4	1	—	—	—	4 6 0	Dr. Stevens.
East Retford	6	3	—	2 18 0	6 5 0	14 5 0	„ Blaxall.
East Stonehouse	1	1	—	—	—	46 13 0	„ Ballard.
Ecclesall Bierlow	3	1	—	—	—	131 3 0	„ Parsons.
Edmonton	13	8	—	3 19 0	90 14 0	220 19 0	Mr. Power.
Ellesmere	7	4	1	2 0 8	7 9 0	19 13 8	Dr. Parsons.
Epsom	8	7	—	3 1 0	17 11 0	60 15 0	„ Stevens.
Erpingham	3	1	—	—	—	18 8 0	„ Airy.
Eton	8	7	—	5 6 0	19 11 0	74 16 0	„ Thorne.
Evesham	5	3	—	1 6 0	13 14 0	21 10 0	Mr. Spear.
Fareham	5	4	—	3 14 0	14 13 0	39 15 0	Dr. Stevens.
Farnham	6	6	—	2 5 0	40 14 0	79 16 0	Do.
Faringdon	4	4	—	2 7 0	10 13 0	26 14 0	Do.
Flegg, East and West	4	—	—	—	—	—	„ Airy.
Fordingbridge	2	2	—	6 15 0	7 12 0	14 7 0	„ Stevens.
Fulham	3	2	—	31 10 0	45 11 0	77 1 0	Do.
George's, St.	4	4	—	7 5 0	75 14 0	142 17 0	Dr. Stevens.
Giles, St., and St. George, Bloomsbury	1	1	—	—	—	58 3 0	Do.
Glanford Brigg	9	1	—	—	—	13 11 0	„ Parsons.
Gloucester	2	1	—	—	—	21 13 0	„ Blaxall.
Godstone	5	4	—	4 13 0	7 16 0	24 15 0	„ Stevens.
Goole	5	4	—	4 8 0	7 4 0	21 8 0	Mr. Spear.
Grantham	7	4	—	3 10 0	19 10 0	36 0 0	Dr. Parsons.
Greenwich	2	2	—	72 5 0	124 15 0	197 0 0	„ Stevens.
Guildford	9	9	—	3 4 0	18 18 0	80 18 0	Do.
Guisborough	4	1	1	23 6 0	38 17 0	62 3 0	Mr. Power.
Hambledon	5	4	—	4 14 0	11 19 0	33 8 0	Dr. Stevens.
Hartley Wintney	6	5	—	5 1 0	8 15 0	35 7 0	Do.
Havant	3	3	—	4 2 0	7 9 0	16 3 0	Do.
Helmsley Blackmoor	2	2	—	5 14 0	12 11 0	18 5 0	Mr. Power.
Hemsworth	4	3	—	2 18 0	21 12 0	39 10 0	Dr. Barry.
Hendon	7	3	—	4 19 0	69 5 0	88 14 0	Mr. Power.
Hereford	4	4	—	10 4 0	38 7 0	79 5 0	„ Spear.
Hinckley	5	2	—	12 0 0	26 17 0	38 17 0	Dr. Parsons.
Holbeach	6	—	—	—	—	—	Do.
Holbeck	1	1	—	—	—	73 6 0	„ Barry.
Holborn	4	4	—	45 17 0	64 3 0	225 2 0	„ Stevens.
Holsworthy	5	1	—	—	—	10 0 0	„ Ballard.
Honiton	12	2	—	1 15 0	11 5 0	13 0 0	Do.
Howden	4	1	—	—	—	5 13 0	Mr. Spear.
Hungerford	5	5	—	6 3 0	13 4 0	43 7 0	Dr. Stevens.
Hursley	1	1	—	—	—	5 6 0	Do.

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APP. A. No. 2.

Inspection of Public Vaccination.

UNION.	No. of Vaccination Districts in the Union.	No. of respective Vaccination Contractors recommended for Award.		Range of Awards in each Union.		Total Sum awarded in the Union.	Inspector.
		1st Class Award.	2nd Class Award.	Minimum.	Maximum.		
				£ s. d.	£ s. d.	£ s. d.	
Keighley	4	—	—	—	—	—	Dr. Barry.
Kensington	2	2	—	48 9 0	124 8 0	172 17 0	„ Stevens.
Kettering	4	1	—	—	—	12 6 0	„ Parsons.
Kidderminster	5	3	—	6 11 0	54 14 0	71 7 0	Mr. Spear.
Kingsbridge	5	3	—	1 16 0	8 4 0	12 16 0	Dr. Ballard.
Kingsclere	3	1	—	—	—	4 9 0	„ Stevens.
King's Norton	7	6	—	8 3 0	54 7 0	131 2 0	Mr. Spear.
Kingston-on-Hull	2	2	—	32 0 0	91 4 0	123 4 0	Dr. Airy.
Kingston-on-Thames	11	9	—	3 1 0	27 15 0	88 1 0	„ Stevens.
Kington	5	3	—	2 19 0	8 17 0	16 1 0	Mr. Spear.
Kirkby Moorside	1	1	—	—	—	13 11 0	„ Power.
Knaresborough	3	1	—	—	—	19 10 0	Dr. Barry.
Lancaster	5	2	—	3 3 0	15 3 0	18 6 0	Dr. Barry.
Ledbury	3	2	—	8 3 0	8 14 0	16 17 0	Mr. Spear.
Leeds	7	6	—	2 3 0	53 11 0	161 8 0	Dr. Stevens.
Leek	5	2	—	7 1 0	14 12 0	21 13 0	„ Parsons.
Leicester	2	2	—	25 16 0	73 19 0	99 15 0	Do.
Leigh	3	2	—	29 19 0	75 3 0	105 2 0	„ Barry.
Leominster	3	3	—	2 4 0	24 17 0	33 19 0	Mr. Spear.
Leyburn	6	2	—	4 4 0	7 17 0	12 1 0	„ Power.
Lichfield	6	4	—	3 16 0	26 18 0	70 13 0	Dr. Parsons.
Liverpool	3	3	—	47 0 0	94 11 0	211 9 0	„ Stevens.
Loughborough	4	3	—	6 11 0	38 15 0	62 12 0	„ Parsons.
Ludlow	5	1	—	—	—	4 7 0	Do.
Lunesdale	5	5	—	0 6 0	10 3 0	19 12 0	„ Barry.
Lutterworth	5	4	—	3 12 0	9 7 0	22 14 0	„ Parsons.
Lymington	4	2	—	1 1 0	7 2 0	8 3 0	„ Stevens.
Madeley	4	2	—	8 1 0	27 3 0	35 4 0	Dr. Parsons.
Malton	6	3	—	8 2 0	10 5 0	28 0 0	Mr. Power.
Manchester	3	3	—	41 3 0	53 5 0	140 13 0	Dr. Stevens.
Mansfield	6	3	—	6 6 0	29 13 0	46 8 0	„ Blaxall.
Market Bosworth	6	4	—	2 2 0	12 8 0	25 10 0	„ Parsons.
Market Harborough	5	—	—	—	—	—	Do.
Martley	6	3	—	3 15 0	7 8 0	18 0 0	Mr. Spear.
Melton Mowbray	6	3	—	5 6 0	6 18 0	17 16 0	Dr. Parsons.
Middlesbrough	4	4	—	16 0 0	171 1 0	287 16 0	Mr. Power.
Monmouth	6	1	—	—	—	4 16 0	„ Spear.
Morpeth	8	3	—	9 14 0	40 17 0	61 15 0	„ Power.
Newark	9	4	—	1 2 0	5 9 0	13 17 0	Dr. Blaxall.
Newbury	3	2	—	9 2 0	14 8 0	23 10 0	„ Stevens.
Newcastle-under-Lyme.	3	—	—		—	—	„ Parsons.
Newcastle-on-Tyne	3	4	—	28 0 0	58 5 0	147 3 0	„ Stevens.
Newent	3	1	—	—	—	7 1 0	„ Blaxall.
New Forest	5	5	—	0 18 0	13 2 0	28 12 0	„ Stevens.
Newport (Salop)	4	1	—	—	—	6 2 0	„ Parsons.
Newport Pagnell	9	5	—	1 3 0	24 12 0	48 8 0	„ Thorne.
Newton Abbot	11	6	—	5 8 0	37 5 0	103 5 0	„ Ballard.
Northallerton	4	1	—	—	—	2 18 0	Mr. Power.
Northampton	4	2	—	13 8 0	28 11 0	41 19 0	Dr. Parsons.
Northleach	5	3	—	2 5 0	7 18 0	15 12 0	„ Blaxall.
Norwich	1	—	—	—	—	—	„ Airy.
Nottingham	3	2	—	56 17 0	65 2 0	121 19 0	„ Blaxall.
Okehampton	6	1	—	—	—	6 0 0	Dr. Ballard.
Olave, St.	3	3	—	94 19 0	137 6 0	336 10 0	„ Stevens.
Oswestry	5	2	—	13 14 0	15 3 0	28 17 0	„ Parsons.
Oundle	4	2	—	6 1 0	10 8 0	16 9 0	Do.
Ouseburn, Great	6	3	—	3 1 0	11 0 0	19 15 0	„ Barry.
Pateley Bridge	3	2	—	2 7 0	9 11 0	11 18 0	Mr. Spear.
Patrington	5	1	—	—	—	4 11 0	Do.
Penistone	3	1	—	—	—	19 15 0	Dr. Parsons.
Pershore	5	4	—	5 11 0	10 19 0	29 16 0	Mr. Spear.
Peterborough	7	4	—	2 19 0	56 19 0	83 17 0	Dr. Parsons.
Petersfield	4	2	—	2 12 0	6 8 0	9 0 0	„ Stevens.

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UNION.	No. of Vaccination Districts in the Union.	No. of respective Vaccination Contractors recommended for Award.		Range of Awards in each Union.		Total Sum awarded in the Union.	Inspector.
		1st Class Award.	2nd Class Award.	Minimum.	Maximum.		
				£ s. d.	£ s. d.	£ s. d.	
Pickering	3	1	—	—	—	4 8 0	Mr. Power.
Plymouth	1	2	—	62 0 0	70 16 0	132 16 0	Dr. Ballard.
Plympton, St. Mary	5	3	—	8 13 0	9 17 0	27 5 0	Do.
Pocklington	6	4	—	1 19 0	6 10 0	18 13 0	Mr. Spear.
Pontefract	7	6	—	5 14 0	41 14 0	123 4 0	Dr. Barry.
Poplar	4	4	—	32 13 0	133 9 0	311 11 0	„ Stevens.
Portsea Island	1	1	—	—	—	158 2 0	Do.
Reading	1	1	—	—	—	68 5 0	Dr. Stevens.
Reeth	2	1	—	—	—	9 18 0	Mr. Power.
Reigate	4	3	—	7 3 0	23 19 0	44 5 0	Dr. Stevens.
Richmond (Surrey)	3	2	—	10 3 0	31 11 0	41 14 0	Do.
Richmond (Yorks.)	5	3	—	4 5 0	8 18 0	19 3 0	Mr. Power.
Ringwood	1	1	—	—	—	13 16 0	Dr. Stevens.
Ripon	4	2	—	5 8 0	12 5 0	17 13 0	„ Barry.
Romsey	5	2	—	5 10 0	9 18 0	15 8 0	„ Stevens.
Ross	4	—	—	—	—	—	Mr. Spear.
Rothbury	6	—	—	—	—	—	„ Power.
Rotherham	8	4	—	12 0 0	85 5 0	178 9 0	Dr. Barry.
Saddleworth	1	1	—	—	—	47 11 0	Dr. Barry.
Salford	3	3	—	44 1 0	93 6 0	230 8 0	„ Stevens.
Saviour, St.	5	5	—	50 14 0	85 1 0	335 14 0	Do.
Scarborough	5	3	—	6 16 0	55 4 0	71 16 0	Mr. Power.
Sculcoates	6	2	—	80 7 0	92 17 0	173 4 0	Dr. Airy.
Sedbergh	2	1	—	—	—	4 5 0	„ Parsons.
Seisdon	4	4	—	4 12 0	9 10 0	30 0 0	Do.
Selby	5	3	1	1 11 0	28 18 0	41 17 8	Mr. Spear.
Settle	7	5	—	0 18 0	7 12 0	14 12 0	Dr. Barry.
Sheffield	6	6	—	12 5 0	55 12 0	203 14 0	„ Stevens.
Shifnal	4	1	—	—	—	8 3 0	„ Parsons.
Shipston-on-Stour	5	5	—	3 15 0	12 2 0	36 15 0	Mr. Spear.
Shoreditch	3	3	—	33 10 0	90 5 0	213 17 0	Dr. Stevens.
Skipton	8	2	—	12 13 0	30 16 0	43 9 0	„ Barry.
Skirlaugh	5	3	—	4 12 0	6 2 0	15 14 0	Mr. Spear.
Sleaford	7	5	—	4 14 0	18 18 0	55 8 0	Dr. Parsons.
Smallburgh	4	3	—	5 5 0	12 5 0	27 11 0	„ Airy.
Southampton	2	2	—	48 5 0	53 12 0	101 17 0	„ Stevens.
South Molton	9	7	1	0 6 8	9 11 0	37 6 8	„ Ballard.
South Shields	3	1	—	—	—	54 13 0	Mr. Spear.
South Stoneham	5	4	—	9 2 0	21 12 0	58 16 0	Dr. Stevens.
Southwell	7	4	—	1 18 0	9 0 0	22 10 0	„ Blaxall.
Spalding	8	—	—	—	—	—	„ Parsons.
Stafford	4	3	—	9 1 0	33 8 0	60 19 0	Do.
Staines	7	1	—	—	—	9 12 0	Mr. Power.
Stamford	7	3	—	1 0 0	27 6 0	32 6 0	Dr Parsons.
Stepney	1	1	—	—	—	107 17 0	„ Stevens.
Stockbridge	2	2	—	7 7 0	8 7 0	15 14 0	Do.
Stoke Damerel	2	—	—	—	—	—	„ Ballard.
Stokesley	4	2	—	6 11 0	12 9 0	19 0 0	Mr. Power.
Stoke-upon-Trent	5	1	—	—	—	37 15 0	Dr. Parsons.
Stone	4	—	—	—	—	—	Do.
Stourbridge	7	5	—	12 8 0	45 6 0	125 6 0	Mr. Spear.
Stow-on-the-Wold	2	2	—	8 12 0	8 18 0	17 10 0	Dr. Blaxall.
Strand	1	—	—	—	—	—	„ Stevens.
Stroud	6	3	—	9 0 0	32 2 0	51 17 0	„ Blaxall.
Tadcaster	5	2	—	6 16 0	18 12 0	25 8 0	Dr. Barry.
Tamworth	3	2	—	4 12 0	22 12 0	27 4 0	„ Parsons.
Tavistock	7	2	—	4 4 0	10 15 0	14 19 0	„ Ballard.
Teesdale	7	3	—	3 12 0	13 4 0	26 1 0	Mr. Spear.
Tenbury	2	2	—	6 16 0	8 15 0	15 11 0	Do.
Tetbury	2	1	—	—	—	10 1 0	Dr. Blaxall.
Tewkesbury	4	2	—	6 7 0	16 3 0	22 10 0	Do.
Thirsk	6	2	1	2 17 0	5 19 0	13 0 8	Mr. Power.
Thomas, St.	17	6	1	1 4 0	9 18 0	36 4 4	Dr. Ballard.
Thornbury	4	2	—	0 14 0	12 19 0	13 13 0	„ Blaxall.
Thorne	6	3	—	3 16 0	15 3 0	26 2 0	Mr. Spear.

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PP. A. No. 2.

Inspection of Public Vaccination.

UNION.	No. of Vaccination Districts in the Union.	No. of respective Vaccination Contractors recommended for Award.		Range of Awards in each Union.		Total Sum awarded in the Union.	Inspector.
		1st Class Award.	2nd Class Award.	Minimum.	Maximum.		
				£ s. d.	£ s. d.	£ s. d.	
Thrapston	5	2	—	9 13 0	11 17 0	21 10 0	Dr. Parsons.
Tiverton	14	2	—	1 6 0	4 4 0	5 10 0	„ Ballard.
Todmorden	2	1	—	—	—	16 0 0	Mr. Spear.
Torrington	5	1	—	—	—	1 19 0	Dr. Ballard.
Totnes	11	1	—	—	—	14 1 0	Do.
Tottenham Park	2	1	—	—	—	89 12 0	„ Stevens.
Upton-on-Severn	5	4	—	1 7 0	13 12 0	24 12 0	Mr. Spear.
Uttoxeter	5	1	—	—	—	5 2 0	Dr. Parsons.
Uxbridge	7	5	—	4 2 0	26 16 0	70 9 0	Mr. Power.
Wallingford	3	2	—	9 5 0	12 1 0	21 6 0	Dr. Stevens.
Walsall	4	3	—	16 2 0	96 18 0	155 0 0	„ Parsons.
Walsingham	6	1	—	—	—	7 5 0	„ Airy.
Wantage	5	1	—	—	—	5 4 0	„ Stevens.
Wellingborough	5	—	1	—	—	5 15 4	„ Parsons.
Wellington (Salop)	3	—	—	—	—	—	Do.
Wells	4	3	—	5 2 0	12 16 0	28 4 0	„ Blaxall.
Wem	4	2	—	5 15 0	5 18 0	11 13 0	„ Parsons.
Weobly	3	2	—	8 12 0	8 14 0	17 6 0	Mr. Spear.
West Bromwich	5	4	—	17 0 0	51 6 0	168 18 0	Dr. Parsons.
Westbury-on-Severn	4	—	—	—	—	—	„ Blaxall.
West Derby	6	4	—	13 15 0	87 12 0	142 19 0	„ Stevens.
Westminster	2	1	—	—	—	24 8 0	Do.
Wetherby	6	3	—	4 0 0	5 9 0	13 17 0	„ Barry.
Wharfedale	3	—	—	—	—	—	Do.
Wheatenhurst	2	1	—	—	—	10 11 0	„ Blaxall.
Whitby	4	1	—	—	—	16 14 0	„ Power.
Whitchurch (Hants)	3	2	—	4 7 0	6 18 0	11 5 0	„ Stevens.
Whitchurch (Salop)	4	3	—	0 15 0	6 11 0	9 9 0	„ Parsons.
Whitechapel	1	1	—	—	—	150 17 0	„ Stevens.
Wight, Isle of	9	7	—	2 3 0	22 12 0	83 1 0	Do.
Winchcomb	2	—	—	—	—	—	„ Blaxall.
Winchester, New	4	4	—	5 0 0	34 2 0	57 7 0	„ Stevens.
Windsor	3	2	—	23 15 0	30 10 0	54 5 0	Do.
Winslow	3	1	—	—	—	9 15 0	„ Thorne.
Wokingham	4	3	—	6 16 0	16 17 0	34 6 0	„ Stevens.
Wolstanton and Burslem.	3	2	—	36 10 0	57 2 0	93 12 0	„ Parsons.
Wolverhampton	5	2	—	45 9 0	59 9 0	104 18 0	Do.
Worcester	1	1	—	—	—	45 0 0	Mr. Spear.
Worksop	7	3	—	2 9 0	25 19 0	35 3 0	Dr. Blaxall.
Wortley	3	1	—	—	—	22 1 0	„ Parsons.
Wycombe	12	8	—	3 7 0	15 6 0	66 4 0	„ Thorne.
Yarmouth, Great	1	1	—	—	—	52 11 0	Dr. Airy.
York	6	5	—	1 13 0	84 10 0	98 17 0	Mr. Spear.
Total	1,350	737	14	—	—	14,264 16 8	

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No. 3.

Statistics of the National Vaccine Establishment and Educational Vaccination Stations.

Ia.—Staff at end of 1882.

N.B.—The Stations named in *italics* are Educational Vaccination Stations authorised by the Local Government Board.

—	Name.	Vaccination Stations.	Days and Hours of Attendance.
Vaccinators supplying lymph for the public service, & salaried from the Parliamentary grant.	1. Dr. R. Cory	*Surrey Chapel*	Tues., Thurs.; 2.
	2. Mr. W. E. G. Pearse	*Tottenham Court Chapel.*	Mon., Wednes.; 1.
Parochial and other Vaccinators not salaried from the Parliamentary grant, but contributing lymph at a fixed rate of payment.	1. Mr. Ellis S. Guest	*Manchester*	Monday; 2.
	2–6. Dr. Edmund Robinson.	*Birmingham*	Monday, Tuesday, Wednesday 11.; Wednesday; 2. Thursday; 11.
	7. Mr. Roger Parker	*Liverpool*	Thursday; 2.30.
	8. Mr. E. L. Webb	*Pimlico*	Thursday; 10.
	9. Mr. J. Hawthorn	*Newcastle-on-Tyne.*	Wednesday; 3.
	10. Mr. W. E. G. Pearse	*Westminster*	Tuesday; 2.
	11–12. Mr. W. A. Sumner	*Marylebone*	Tuesday; 2. Wednesday; 10.
	13. Mr. C. T. Blackman	*Whitechapel*	Wednesday; 11.
	14. Mr. Frederick Holmes	*Leeds*	Tuesday; 2.30.
	15. Dr. Edward Lynes	Coventry	Tuesday; 12.
	16. Dr. Hugh Thomson	*Glasgow*	Monday; 12.
	17. Mr. Robert W. Dunn	*Strand*	Thursday; 11.
	18. Mr. Matthew Brownfield	Bromley, Middlesex.	Tuesday; 3.
	19. Mr. W. Skinner	*Sheffield*	Tuesday; 3.
	20. Dr. A. C. Clarke	Salford	Thursday; 2.
	21. Mr. N. Miskin	Waterloo	Tuesday; 2.
	22. Mr. T. F. Morrish	Toxteth Park	Tuesday; 11.
	23. Dr. J. O. Affleck	*Edinburgh*	Wednes., Sat.; 12.
	24. Dr. R. Cory	*St. Thomas's Hosp.*	Wednesday; 11.30.
	25. Dr. D. C. McVail	*Glasgow West*	Monday; 1.
Teachers of Vaccination not supplying lymph	Dr. W. Husband	*Edinburgh*	Wednes., Sat.; 12.
	Dr. R. D. Tannahill	*Glasgow*	Mond., Thurs.; 12.
	Mr. H. Lawrence	*Bristol*	Wednesday; 10.
	Mr. J. Gittins	*Horsleydown*	Monday; 2.
	Mr. William A. Budd	*Exeter*	Thursday; 3.

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App. A. No. 3.

National Vaccine Establishment.

Ib.—Animal Vaccination.

The Animal Vaccine Station is at 95, Lamb's Conduit Street, where Dr. R. Cory and Mr. S. F. Murphy attend for the Vaccination of Children on Tuesdays and Thursdays, from 10.30 a.m. to 12 noon.

II.—Sources and Amount of Lymph Supply in 1882.

N.B.—The Stations named in *italics* are Educational Vaccination Stations authorised by the Local Government Board.

—	Vaccination Stations.	Number of Vaccinations performed at the Stations respectively.		Number of Charges of Lymph supplied from the Stations respectively.	
		Primary.	Re-vaccinations.	Charged ivory Points.	Charged Tubes each estimated as equal to 10 ivory Points.
Vaccinators salaried from the Parliamentary grant.	1. *Surrey Chapel*	362	38	5,089	—
	2. *Tottenham Court Chapel.*	944	50	160*	737
	Total -	1,306	88	5,249	737
Parochial and other Vaccinators not salaried from the Parliamentary grant, but contributing lymph at a fixed rate of payment.	1. *Manchester*† -				
	2–6. *Birmingham* -	5,227	620	—	3,596
	7. *Liverpool* -	1,443	1	—	847
	8. *Pimlico* - -	482	84	—	492
	9. *Newcastle-on-Tyne.*	626	171	—	781
	10. *Westminster* -	833	95	—	951
	11–12. *Marylebone* -	1,646	147	—	141
	13. *Whitechapel* -	1,719	33	—	292
	14. *Leeds* - -	1,056	—	—	279
	15. Coventry -	984	4	—	1,414
	16. *Glasgow* - -	906	1	—	282
	17. *Strand* - -	459	12	—	—
	18. Bromley - -	1,489	32	—	14
	19. *Sheffield* - -	1,146	—	—	331
	20. Salford - -	694	4	—	572
	21. Waterloo -	684	14	—	1,400
	22. Toxteth Park -	1,536	4	—	1,634
	23. *Edinburgh* -	1,187	7	—	35
	24. *St. Thomas's Hospital.*§	228	8	—	64
	25. *Glasgow West*	740	—	—	—
	Total -	23,085	1,237	—	13,124
	Grand Total -	24,391	1,325	5,249	13,861

* This number includes 40 charged glasses, each estimated as equal to four charged ivory points.

† No information received from this station.

§ Information for five months only received from this station.

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II.—Sources and Amount of Lymph, &c.—*continued.*

During the year additional supplies (to the extent of 8,056 charged tubes) were obtained from the following gentlemen:—

Mr. C. C. Claremont, Hampstead Road.
Mr. W. Kempster, Battersea East.
Mr. G. A. H. Hepworth, Gloucester.
Mr. J. Oakman, Battersea West.
Mr. W. Arthur, Kennington.
Mr. H. May, Aston.
Mr. H. W. Newton, Newcastle-on-Tyne.
Mr. W. H. W. Wilkinson, Liverpool Road.
Mr. J. P. Purvis, Greenwich.
Mr. J. W. Kay, St. George's-in-the-East.
Dr. N. E. Roberts, Toxteth Park.
Dr. T. N. Orchard, Pendleton.
Mr. T. M. Johnson, Salford.

III.—Distribution of Human Lymph, 1882.

Number of applications:	
From Medical Practitioners in England and Wales	8,114
„ „ „ Scotland	247
„ the Army	439
„ the Navy and from the Emigration Department	105
„ India and the Colonies	157
„ Diplomatic and other Foreign Services	80
Total	9,142
Supplies sent out:—	
Charged ivory points	5,007
„ squares of glass	40
„ capillary tubes	21,483

IV. Calf-Lymph, 1882.

Number of applications	589
Amount received:—	
Charged points	3,655
„ tubes	471
Supplies sent out:—	
Charged ivory points	2,872
„ capillary tubes	270

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No. 4.

ABSTRACT of MEDICAL INSPECTIONS made in 1882 with regard, generally, to the INCIDENCE of DISEASE on particular places, and to consequent Questions concerning the LOCAL SANITARY ADMINISTRATION.

Area of Inquiry and Name of Inspector.	Ground of Inquiry.	Jurisdiction concerned.	Chief Facts reported by Inspector.
1. Ampthill - - (Bedfordshire.) *Dr. Thorne.*	Information from Medical Officer of Health.	Ampthill guardians and rural sanitary authority.	Under the emergency of an outbreak of small-pox attacking the inmates of the workhouse and the residents in Ampthill town, a portion of the workhouse was used as a temporary hospital for the isolation of those attacked. All further spread of infection to the inmates was stayed by re-vaccination. Apart from one unvaccinated infant no fatal case occurred under the age of puberty, and out of a total of 107 attacks in the district no person protected by re-vaccination was affected.
2. Andover - - (Hants.) Population, 10,047. *Dr. Blaxall.*	Unsatisfactory character of the reports of the Medical Officer of Health.	Andover rural sanitary authority.	Certain dwellings in an extreme state of dilapidation. District undrained. Midden privies a source of nuisance and dangerous to health. Water supply abundant in the valleys, but very scarce on the hills; wells sunk in a filth-sodden soil, exposing the water to dangerous pollution. Frequent prevalence of nuisance around houses particularly from improper storage of excrement and refuse, and from pools of house-slops. Failure on the part of the Medical Officer of Health and the Inspector of Nuisances to comprehend the nature and scope of the duties required of them.
3. Ashton-under-Lyne - (Lancashire.) Population, 37,040. *Dr. Ballard.*	Local request - -	Ashton-under-Lyne town council.	Crowding of houses on area with insufficient space about them. Abundant nuisances found. Accumulations of excrement and house refuse and bad construction of privies. In some parts neglect of proper making of roadways. High general death-rate, and especially high death-rate among children and from preventable causes.
4. Bangor and Bethesda. (Carnarvonshire.) *Dr. Barry.*	Local information -	Bangor urban, Bethesda urban, and Bangor rural sanitary authorities.	Extensive outbreak of enteric fever occurring simultaneously over the area supplied by the Bangor waterworks, and limited to the consumers of the water obtained therefrom. Direct communication ascertained to exist by means of a drain between a house occupied by persons suffering from enteric fever and the source of the water supply, and thence, in consequence of imperfection in filtering arrangements, directly to the consumers of the water. The subsequent spread of the disease promoted by the connection established between the houses and ill ventilated sewers, and the accumulation of filth in proximity to houses. Want felt of hospital accommodation for infectious diseases, and of a disinfecting apparatus.
5. Bedwelty Registration District (*part.*) (Monmouthshire.) Population, 34,716. *Mr. Spear.*	Registrar General's Returns, and reports of Medical Officers of Health.	Abertillery urban sanitary authority.	*Abertillery Urban Sanitary District.*—(Pop. 6,000.)—Localised prevalence of enteric fever in 1882, associated apparently with the use of a certain water supply. Extensive prevalence of scarlatina in 1881 and 1882; its wide diffusion supervening upon the existence for some months of sporadic cases. No means for dealing effectively with epidemic disease. No proper system of sewerage; parts of district not provided with wholesome water supply. Prevalence of privy and drain nuisances.

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Area of Inquiry and Name of Inspector.	Ground of Inquiry.	Jurisdiction concerned.	Chief Facts reported by Inspector.
5. Bedwelty Registration District (*part*) —*cont.*	Registrar General's Returns, and reports of Medical Officers of Health.	Ebbw Vale urban sanitary authority.	*Ebbw Vale Urban District.*—(Pop. 15,519.)—An almost house-to-house prevalence of enteric fever in small detached hamlet in 1881, ascribed by Medical Officer of Health to excremental pollution of atmosphere from privy and other nuisances. Public water supply had, however, at time failed, and inhabitants had largely resorted to questionable sources. Notable fact also (which, however, received no explanation) that working lads (employed in a colliery) of families invaded, unusually often first to be attacked. Extensive prevalence of scarlatina, the disease spreading from one hamlet to another, in years 1881-82. No provision for isolation. Part of district not supplied from public water mains; and supply then improper. Prevalence of sewage nuisances. Byelaws obsolete.
		Bedwelty rural sanitary authority.	*Bedwelty Rural District.*—(Pop. 13,197.)—Parts of this district urban in character, others rural. In former, extensive prevalence of scarlatina throughout 1882; in one of the hamlets of the latter, prevalence of diphtheria. Localised prevalence of typhoid in 1881. Large proportion of the population very poor; very many houses quite unfit for habitation; no means of sewerage; many houses unprovided with privy accommodation; no paving, &c., of surface about dwellings. Water supply very deficient in quantity and, when obtained, generally polluted. No means of isolation.
6. Brierley Hill (Worcestershire.) Population, 11,603. *Dr. Parsons.*	Local complaint	Brierley Hill local board.	Private wells in use in certain parts of the town in dangerous proximity to privies, dumb-wells, pigstyes, and other sources of pollution. The wells are sunk through clay into a water-bearing bed of loose rock, and it seems to be the practice to puddle the upper part of the well to exclude surface soakings, but the outcrop of the water-bearing bed being in a town, the water appears to carry down impurities from the gathering ground. Public water service furnished by South Staffordshire Waterworks Company, but not extended to all parts of town, impure supplies consequently in use. Privies with foul open cesspits. Pig-keeping nuisances. Want of proper sewerage in outlying parts of town.
7. Clapham. (Surrey.) *Dr. Parsons.*	Enteric fever. Local complaint.	Wandsworth District Board of Works.	Outbreak of typhoid fever in June and July 1882, of limited extent, occurring for the most part in houses of the best class, and attacking (with one exception capable of being otherwise accounted for) only persons getting milk from a particular dealer at Clapham, and especially large milk drinkers. The milk used by the patients had come from two farms near Axminster, no fever having occurred among persons using milk from the dealer's own cows. The mode in which the milk became infected was not ascertained but there had been cases of fever some months before in the place from which it came, and the well water at both farms was found on analysis to be contaminated with sewage products.
8. Coggeshall and neighbourhood. (Essex.) *Dr. Airy.*	Information from the Medical Officer of Health as to epidemic of diphtheria.	Braintree rural sanitary authority.	Serious epidemic of diphtheria, especially among children attending one particular school. Origin uncertain. Spread chiefly by personal communication. Drainage into watercourses. Water supply, partly by pipes, partly by carts, from good spring, imperfectly secured from pollution. No public means of isolation.

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Area of Inquiry and Name of Inspector.	Ground of Inquiry.	Jurisdiction concerned.	Chief Facts reported by Inspector.
9. Dartford Registration District. (Kent.) Population 22,439. *Mr. Spear.*	Registrar General's Returns.	Dartford local board -	*Dartford Urban Sanitary District.*—(Pop. 10,159).—Prevalence of enteric fever, localised to low-lying portion of town, during 1881 and part of 1882. In parts invaded, subsoil water stands 3 or 4 feet only from the surface; and into this water-level wells and cesspools are sunk indifferently. At time of fever outbreak sewers were being constructed, pumping operations being needed to lower subsoil water; wells and cesspools were often pumped dry. Wells, on again receiving soakage, of necessity much polluted. 40 per cent. of houses in this low-lying district supplied from local wells, remainder from Kent Water Company's mains (everywhere available); in former, over 80 per cent. of fever attacks occurred. In addition to defects of water supply, cesspool and other nuisances very common.
		Dartford rural sanitary authority.	*Part of Dartford Rural Sanitary District.*—(Pop. 11,280.)—Localised and recurring outbreaks of diphtheria. Initial cases occurring in houses where gross sanitary defects existed, and in spots where diphtheria had previously been observed; disease then apparently spreading through schools. Parts of this district rapidly extending, yet no bye-laws. Houses being built without any regard to sanitary requirements. Very little inspection for sanitary purposes.
10. Folkestone - - (Kent.) Population, 18,717. *Dr. Parsons.*	Diphtheria. Regis.-General's Returns.	Folkestone town council acting as improvement commissioners.	Epidemic of diphtheria in winter and spring of 1881-2, chiefly affecting certain suburbs inhabited by the working classes. Disease propagated in part by personal intercommunication, and associated in most instances with conditions facilitating the entry of sewer-air into houses. Insufficient ventilation and flushing of sewers and drains. Polluted shallow wells. Hospital accommodation not sufficiently made use of.
11. Galgate - - (Lancashire.) Population, 748. *Dr. Barry.*	Request of local authority.	Lancaster rural sanitary authority.	Outbreak of enteric fever in August, 1882, among persons drinking water obtained from a well contaminated with excremental matter. Water supply of village insufficient; wells of doubtful purity resorted to. Midden privies a source of nuisance and of grave injury to health. No means of isolation or efficient disinfection.
12. Guildford, Dorking, and neighbourhood. (Surrey.) *Mr. Power.*	Outbreak of diarrhœa. Report by Medical Officer of Health of Guildford rural sanitary district.	Guildford, Dorking, and Hambledon rural sanitary authorities.	Sudden epidemic of diarrhœa extending over many country parishes, attacking adults and children, but not babies. Absence among invaded houses of community of sanitary conditions that would suffice to account for the observed distribution of the malady. Detailed inquiry (embracing above two dozen articles of food) into the food circumstances of invaded families, upon the whole negative.
13. Helston, Redruth, and Falmouth Unions. (Cornwall.) *Dr. Ballard.*	As to Medical Officer of Health arrangements.	Helston rural sanitary authority.	*Helston Rural Sanitary District* (Pop. 20,249).—General inefficiency of the arrangements under which the District Medical Officers had hitherto acted as Medical Officers of Health, and of sanitary administration by the authority. Serious nuisances from accumulations of filth, absence or inefficiency of drainage and want of due privy accommodation throughout the district. In many places deficiency of water supply, or a supply of very questionable wholesomeness. Great prevalence of phthisis.

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Area of Inquiry and Name of Inspector.	Ground of Inquiry.	Jurisdiction concerned.	Chief Facts reported by Inspector.
13. Helston, Redruth, and Falmouth Unions.—*cont.*	As to Medical Officer of Health arrangements.	Helston town council	*Helston Urban Sanitary District.* (Pop. 3,432.)—Very negligent sanitary administration. Excrement nuisances and nuisances from want of proper drainage, abounding everywhere. Many houses without privy accommodation. No supervision of common lodging-houses.
		Redruth rural sanitary authority.	*Redruth Rural Sanitary District.* (Pop. 18,938).—General inefficiency of sanitary administration and of the arrangements under which the District Medical Officers fill the posts of Medical Officers of Health. Little or no improvement (except in the Illogan district) in the sanitary condition of the district since Dr. Blaxall's inspection in 1877.
		Redruth local board -	*Redruth Urban Sanitary District.* (Pop. 9,335).—Inefficient sanitary administration and medical supervision. Sanitary condition of district much as it was at the time of Dr. Blaxall's inspection in 1877.
		Camborne local board.	*Camborne Urban Sanitary District.* (Pop. 13,601).—General efficiency of Medical Officer of Health and sanitary improvement of district.
		Phillack local board -	*Phillack Urban Sanitary District.* (Pop. 3,643.)—Inefficient sanitary administration generally. Sanitary condition of district much the same as when reported on by Dr. Blaxall in 1877. District very filthy from excrement and drainage nuisances, the removal of which the authority does not duly enforce, and the recurrence of which it does not endeavour to prevent.
		Hayle local board -	*Hayle Urban Sanitary District.* (Pop. 1,089).—Inadequate apprehension of his functions by the Medical Officer of Health.
		Falmouth rural sanitary authority.	*Falmouth Rural Sanitary District.* (Pop. 9,960).—Medical Officer of Health doing his best, and on the whole satisfactorily. Considerable improvement in district since passing of Public Health Act.
		Falmouth town council.	*Falmouth Municipal Borough.* (Pop. 5,973).—Medical Officer of Health doing his work satisfactorily.
		Falmouth (parish) local board.	*Falmouth (Parish) Urban Sanitary District.* (Pop. 6,158).—Medical Officer of Health doing his work satisfactorily.
		Penryn town council.	*Penryn Urban Sanitary District.* (Pop. 3,466.)—Medical Officer of Health doing his best, and on the whole satisfactorily. Much improvement needed in the town, especially in respect of privies and sewer ventilation.
14. Hindley - - (Lancashire.) Population, 14,669. *Mr. Spear.*	Inadequacy of reports of Medical Officer of Health.	Hindley urban sanitary authority.	Omissions of reporting on part of Medical Officer of Health consequent upon neglect of the active duties of the office. Absence of any means for dealing with spread of infectious diseases. Many "filth" nuisances, arising from want of due sanitary supervision; a certain number of houses quite unfit for habitation. Byelaws (made in 1876) not well adapted to special wants of district; and houses now being built without sufficient regard to sanitary requirements.

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No. 5.

App. A. No. 5.

On the Operations of the Animal Vaccine Establishment; by Shirley F. Murphy.

On the Operations of the Animal Vaccine Establishment; by Mr. Murphy.

The last report gave an account of the earlier operations of the establishment in the temporary premises situated in the stoneyard of the workhouse of St. Mary Abbott, Kensington, where arrangements were made for the cultivation of calf-lymph and its supply to the National Vaccine Establishment, but where there was no opportunity for the vaccination of children direct from the calf.

The present report, in continuation of the last, refers to a period beginning with the opening of the permanent premises in Lamb's Conduit Street in the early part of April 1882, since which date, in addition to the cultivation of calf-lymph, a number of persons have been vaccinated at the station.

Permanent premises in Lamb's Conduit Street.

The premises consisted originally of some newly erected stables in the rear of houses in Lamb's Conduit Street. These were altered so as to meet the requirements of the establishment.

The ground floor of the house 95, Lamb's Conduit Street was converted into an entrance hall, giving access to a waiting-room measuring 32 × 29 feet. The waiting-room opens into another room measuring 25 × 30 feet, and divided into two parts by a screen, on either side of which the vaccination of children and calves are performed. On the side of this operating-room further from the waiting-room is a passage leading to a furnace-room, a store room, and three stables for calves.

Each stable measures on on average 15½ feet by 9½ feet, and is fitted with four stalls; each calf, therefore, has a floor space of 36·7 feet.

The floor of the whole institution is made of concrete, and in the stables has a fall to a channel which opens into a trapped drain. The walls are of brick and covered with cement to about four feet from the floor. The divisions between the stalls are made of slate, the troughs, &c. of iron.

Each room and stable is heated with hot-water pipes, so arranged that the heat in any one can be maintained independently of the others.

Adjoining these rooms is a yard containing an isolation stable, to which can be removed any calf which it may be desirable to separate from the others, waterclosets for the convenience of the public, a manure bin, and an enclosed receptacle for boiling milk.

The floor above is devoted to a resident caretaker and his family, one room being retained for microscopic purposes.

Days for vaccination of children.

On April 11, 1882 the station was opened for the vaccination of children and adults, vaccinations taking place every Tuesday and Thursday from 10.30 a.m. to 12 noon.

The need for the lymph-supply to fall upon these days has led to the days of vaccination of calves being appointed as follows:—

Days for vaccination of calves.

A calf is vaccinated on Saturday with lymph stored in tubes. This calf supplies lymph on the following Thursday for—

a. The direct vaccination of children at the station;

b. The supply of lymph to the National Vaccine Establishment;

c. The direct vaccination of another calf;

d. The vaccination of another calf on the following Saturday.

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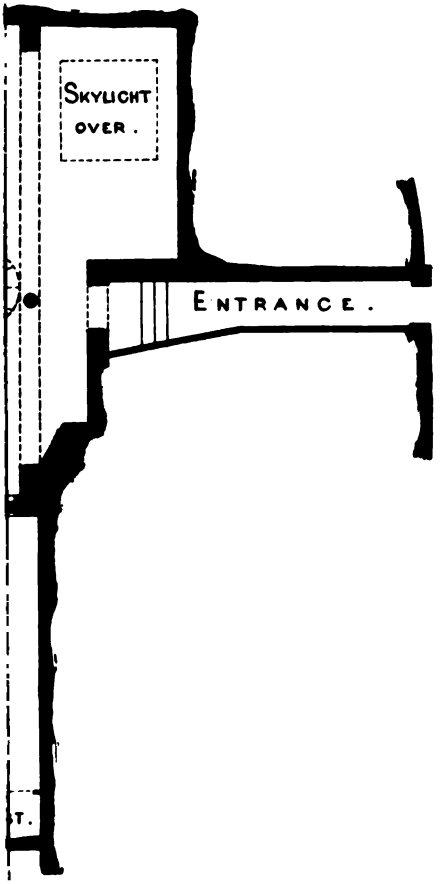

LAMB'S CONDUIT STREET.

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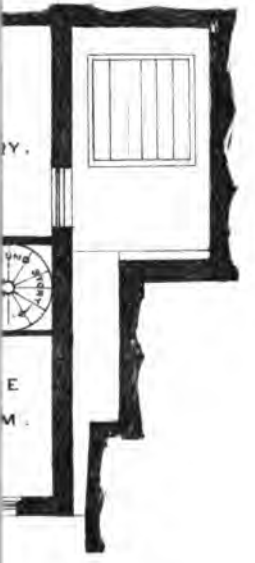

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The calf vaccinated on Thursday provides lymph on Tuesday for—

a. The direct vaccination of children at the station;

b. The supply of lymph to the National Vaccine Establishment.

As a matter of practice it is also customary to retain for subsequent use a few tubes of lymph derived from the best developed vesicles. This becomes available in case of any deterioration in the quality of the vesicles.

From April 1882 until July 1882 the duration of the stay of a calf in the station amounted to 14 days. Experience gained during this time showed the need for an additional calf to be maintained in case of any unfitness of a calf for vaccination. After July, therefore, one of the two calves received every week was retained three instead of two weeks.

In November of the same year it was thought desirable to double the number of calves vaccinated every week, and since that month two calves have been vaccinated every Thursday and every Saturday.

Inspection of calves.

The calves on their arrival were placed in the isolation stable until they had been approved by an inspector of the Veterinary Department of the Privy Council as fit for inoculation, and they were then admitted into the other stables.

These arrangements were continued until, in February 1883, the prevalence of foot-and-mouth disease in the country made it necessary that special precautions should be taken to prevent the infection with this disease of the calves in the Animal Vaccine Establishment.

Thenceforward the calves were subjected to preliminary observation, being first received into "quarantine" premises which had been secured for this purpose in Somers Town, N.W. They were retained in this station for six days, and were only conveyed to Lamb's Conduit Street after their freedom from foot-and-mouth disease was assured and they were otherwise in good health.

With a view to preventing subsequent infection, precautions were taken in the manner of removal of the calves from one station to the other, and means were taken to prevent the introduction into the institution of disease conveyed in the milk or by the manure cart. The result has been altogether satisfactory, and the calves have remained in good health.

Origin and descent of lymph.

The lymph stock in use at the time of the last report has been continued until the present time. It was obtained originally on November 26th, 1881, at a farm in the village of Laforêt not far from Bordeaux, and a sample of lymph from the 17th calf in succession from the original one was sent by Dr. Dubreuilh of Bordeaux to the Medical Officer of the Local Government Board.

Calf 50 was vaccinated with this lymph, and the stock maintained since by vaccination of successive calves.

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The following Table (Table I.) shows the descent of the *Lymph*, the *Weight*, *Sex*, and *Colour* of the *Calf*, and the character of the *Vesicles*.

Table I.

Date of Vaccination and Number of Calf, placed in order of date of Vaccination.	Origin and Descent of Lymph.	Weight of Calf. lbs. av.	Sex.	Colour.	Character of Vesicles.
1882.					
April 6 - Calf 54	From calf 51 & 52	136	M	Roan - -	Moderate.
„ 8 - „ 55	„ 52 -	148	M	Do. - -	Good.
„ 13 - „ 56	„ 55 -	420	F	White - -	Moderate.
„ 15 - „ 57	„ 55 & 56	374	F	Do. - -	Good.
„ 20 - „ 58	„ 57 -	154	F	Do. - -	Do.
„ 22 - „ 59	„ 57 -	134	F	Do. - -	Do.
„ 27 - „ 60	„ 59 -	221	M	Red and white -	Moderate.
„ 29 - „ 61	„ 59 -	174	M	Do. - -	Do.
May 4 - „ 62	„ 61 -	176	M	Red - -	Good.
„ 6 - „ 63	„ 61 -	189	M	Roan - -	Moderate.
„ 11 - „ 64	„ 63 -	186	M	Do. - -	Do.
„ 13 - „ 65	„ 63 -	187	M	Do. - -	Do.
„ 18 - „ 66	„ 65 -	152	M	White - -	Good.
„ 20 - „ 67	„ 65 -	146	M	Roan - -	Do.
„ 22 - „ 68	„ 67 and Bordeaux stock.	322	F	Do. - -	Moderate.
„ 27 - „ 69	From calf 51 -	249	F	Do. - -	Good.
June 1 - „ 70	„ 69 -	312	F	Do. - -	Do.
„ 3 - „ 71	„ 69 -	233	F	Do. - -	Do.
„ 8 - „ 72	„ 71 -	282	F	Red and white -	Do.
„ 10 - „ 73	„ 71 -	288	F	Do. -	Moderate.
„ 15 - „ 74	„ 73 -	261	F	Do. -	Good.
„ 17 - „ 75	„ 69 & 71	261	F	Do. -	Do.
„ 22 - „ 76	„ 75 -	235	F	Do. -	Moderate.
„ 24 - „ 77	„ 75 & 59	217	M	Do. -	Do.
„ 29 - „ 78	„ 77 -	222	F	Roan - -	Very good.
July 1 - „ 79	„ 77 -	178	F	Do. - -	Good.
„ 6 - „ 80	„ 79 -	234	M	Red and white -	Do.
„ 8 - „ 81	„ 79 -	213	M	Do. -	Moderate.
„ 13 - „ 82	„ 78 -	228	F	Do. -	Do.
„ 15 - „ 83	„ 79 -	156	F	Do. -	Good.
„ 20 - „ 84	„ 83 -	256	M	Do. -	Moderate.
„ 22 - „ 85	„ 83 -	238	M	Do. -	Very good.
„ 29 - „ 86	„ 85 -	238	M	Red - -	Good.
Aug. 3 - „ 87	„ 86 -	248	M	Red and white -	Do.
„ 5 - „ 88	„ 85 -	277	M	Blue - -	Very good.
„ 10 - „ 89	„ 88 -	278	M	Do. - -	Do.
„ 12 - „ 90	„ 87 -	301	M	Red and white -	Moderate.
„ 17 - „ 91	„ 90 -	276	M	Do. -	Good.
„ 19 - „ 92	„ 89 -	274	M	Roan - -	Very good.
„ 24 - „ 93	„ 92 -	276	M	Red and white -	Indifferent.
„ 26 - „ 94	„ 92 -	251	M	Do. -	Moderate.
„ 31 - „ 95	„ 88 -	251	M	Do. -	Good.
Sept. 2 - „ 96	„ 83 -	348	M	Do. -	Moderate.
„ 7 - „ 97	„ 96 -	266	F	Do. -	Very good.
„ 9 - „ 98	„ 95 -	285	M	White - -	Do.
„ 14 - „ 99	„ 98 -	353	M	Do. - -	Good.
„ 16 - „ 100	„ 98 -	290	M	Blue and white -	Very good.
„ 21 - „ 101	„ 100 -	301	M	Blue - -	Moderate.
„ 23 - „ 102	„ 100 -	404	F	White - -	Indifferent.
„ 28 - „ 103	„ 102 -	346	F	Red and white -	Very good.
„ 30 - „ 104	„ 100 & 97	304	M	Red - -	Indifferent.
Oct. 5 - „ 105	„ 103 -	280	M	Blue - -	Good.
„ 7 - „ 106	„ 103 -	322	M	Red and white -	Very good.
„ 12 - „ 107	„ 106 -	276	M	Red - -	Moderate.
„ 14 - „ 108	„ 106 -	327	M	Do. -	Do.
„ 19 - „ 109	„ 108 -	312	M	Do. -	Good.
„ 21 - „ 110	„ 108 -	364	M	Red and white -	Moderate.
„ 26 - „ 112	„ 110 -	364	F	White - -	Good.
„ 28 - „ 113	„ 109 -	347	F	Red and white -	Moderate.
Nov. 2 - „ 114	„ 112 & 113	354	F	Do. -	Do.
„ 4 - „ 115	„ 112 -	370	F	Do. -	Failed.
„ 9 - „ 116	„ 105 -	315	F	Red - -	Good.
„ 11 - „ 118	„ 105 -	196	F	White - -	Good.
„ 16 - „ 119	„ 118 -	270	F	Do. -	Moderate.
„ 16 - „ 120	„ 103 -	258	M	Roan - -	Do.
„ 16 - „ 120	„ 118 -	258	M	Do. -	Good.
„ 18 - „ 121	„ 116 & 118	274	M	Yellow and white	Do.
„ 18 - „ 122	„ 118 -	270	F	Red and white -	Indifferent.
„ 23 - „ 123	„ 121 -	242	M	Roan and white -	Very good.

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Date of Vaccination, and Number of Calf, placed in order of date of Vaccination.	Origin and Descent of Lymph.	Weight of Calf. lbs. av.	Sex.	Colour.	Character of Vesicles.
1882.					
Nov. 23 - Calf 125	From calf 121 -	336	M	Red - -	Good.
„ 25 - „ 126	„ 121 -	332	F	Red and white -	Indifferent.
„ 25 - „ 127	„ 121 -	280	M	Do. -	Moderate.
„ 30 - „ 128	„ 123 -	294	M	Roan and white -	Do.
„ 30 - „ 129	„ 127 & 123	266	M	Do. -	Indifferent.
Dec. 2 - „ 130	„ 123 -	285	M	Black - -	Indifferent.
„ 2 - „ 131	„ 123 -	280	M	Black and white	Good.
„ 7 - „ 132	„ 130 & 131	280	M	Red and white -	Do.
„ 7 - „ 133	„ 131 -	224	M	Roan - -	Moderate.
„ 7 - „ 133	„ 110 -	224	M	Do. -	Indifferent.
„ 9 - „ 134	„ 118 & 131	356	F	Black - -	Moderate.
„ 9 - „ 135	„ 131 & 110	290	M	Blue - -	Good.
„ 14 - „ 136	„ 135*b* -	274	M	Spot - -	Indifferent.
„ 14 - „ 137	„ 135*b* -	252	M	Red and white -	Moderate.
„ 16 - „ 138	„ 135*b* -	298	M	Blue - -	Do.
„ 16 - „ 139	„ 135*b* -	266	F	White - -	Indifferent.
„ 21 - „ 141	„ 138 -	222	M	Red and white -	Good.
„ 21 - „ 142	„ 132*b* -	260	M	Roan - -	Do.
„ 21 - „ 142	„ 51 -	260	M	Do. -	Indifferent.
„ 23 - „ 143	„ 132*b* -	236	M	Yellow and white	Moderate.
„ 23 - „ 144	„ 131 -	246	M	Red - -	Good.
„ 28 - „ 145	„ 144 -	244	M	Red and white -	Do.
„ 28 - „ 146	„ 143 -	270	F	Roan - -	Indifferent.
„ 30 - „ 147	„ 143 -	258	M	Red - -	Good.
„ 30 - „ 148	„ 144 -	210	F	Blue - -	Moderate.
1883.					
Jan. 4 - „ 149	„ 147 -	274	M	Red and white -	Very good.
„ 4 - „ 150	„ 148 -	252	F	Brown - -	Do.
„ 6 - „ 151	„ 147 -	255	M	Roan - -	Indifferent.
„ 6 - „ 152	„ 145 -	224	M	Black - -	Moderate.
„ 11 - „ 153	„ 152 -	162	M	Red - - -	Good.
„ 11 - „ 154	„ 145 -	160	M	Red and white -	Failed.
„ 13 - „ 155	„ 150 -	260	M	Spotted - -	Indifferent.
„ 15 - „ 156	„ 147 -	280	M	Roan - -	Do.
„ 18 - „ 157	„ 50 -	262	M	Red and white -	Moderate.
„ 18 - „ 158	„ 155 -	242	M	Red - -	Indifferent.
„ 20 - „ 159	„ 148 -	397	F	Black and white	Very good.
„ 20 - „ 160	Original Bordeaux lymph.	208	M	Black - -	Good.
„ 23 - „ 161	From calf 157 -	214	M	Black and grey -	Moderate.
„ 25 - „ 162	„ 159 -	143	F	Red - -	Good.
„ 25 - „ 163	„ 160 -	258	M	Do. - -	Very good.
„ 27 - „ 164	„ 161 -	174	M	Do. - -	Indifferent.
„ 27 - „ 165	„ 161 -	206	M	Do. - -	Do.
Feb. 1 - „ 166	„ 165 -	300	M	Red and white -	Good.
„ 3 - „ 167	„ 163 -	294	M	Red - -	Do.
„ 3 - „ 168	„ 163 -	392	M	Black - -	Indifferent.
„ 6 - „ 169	„ 166 -	400	M	Red and white -	Moderate.
„ 8 - „ 170	„ 167 -	168	M	Roan and white -	Very good.
„ 8 - „ 171	„ 167 -	258	M	Black and white	Do.
„ 10 - „ 173	„ 167 -	154	M	Do. - -	Do.
„ 10 - „ 174	„ 169 -	240	F	Black - -	Good.
„ 15 - „ 172	„ 173 -	168	M	Red - -	Very good.
„ 15 - „ 175	„ 178 -	120	M	Do. - -	Good.
„ 17 - „ 176	„ 173 -	168	F	Red and white -	Very good.
„ 17 - „ 177	„ 173 -	170	F	Red - -	Good.
„ 22 - „ 178	„ 176 -	122	M	Do. - -	Do.
„ 22 - „ 179	„ 177 -	112	M	Red and white -	Moderate.
„ 24 - „ 180	„ 176 -	124	M	Roan - -	Do.
„ 24 - „ 181	„ 176 -	124	M	Red - -	Very good.
Mar. 1 - „ 182	„ 181 -	154	M	Red and white -	Moderate.
„ 1 - „ 183	„ 181 -	134	M	Roan - -	Do.
„ 3 - „ 184	„ 181 -	154	F	Yellow and white	Very good.
„ 8 - „ 186	„ 184 -	164	F	Roan and white -	Very good.
„ 10 - „ 185	„ 184 -	300	M	Red and white -	Indifferent.
„ 15 - „ 187	„ 185 -	280	M	Red - -	Good.
„ 17 - „ 188	„ 186 -	130	F	Red and white -	Do.
„ 22 - „ 189	„ 188 -	173	F	Red - -	Very good.
„ 22 - „ 190	„ 188 -	168	M	Red and white -	Indifferent.
„ 24 - „ 192	„ 188 -	160	M	Do. -	Very good.
„ 24 - „ 194	„ 188 -	204	M	Roan - -	Not stated.
„ 29 - „ 195	„ 192 -	145	M	Do. -	Moderate.
„ 29 - „ 196	„ 192 -	152	M	Red and white -	Do.
„ 31 - „ 197	„ 192 -	142	M	Do. -	Good.
„ 31 - „ 191	„ 192 -	198	M	Do. -	Moderate.

Calves Nos. 53, 111, 117, 124, 140, and 193 were out of health, and were not vaccinated at all.

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Weight of calves.

The average weight of the calves on admission was 247·0 lbs., on leaving 264·9 lbs., giving an average increase of weight for each calf of 17·9 lbs. Of the total number of calves all increased in weight but 11, in 4 there was no change of weight, and in 7 there was a loss.

The character of the vesicle appears to have been influenced by the weight of the calf, the heavier calves producing less satisfactory results than the lighter, a result probably due in a great extent to the age of the calf, the finer skin on the younger calf producing the better vesicles. Latterly a record has been kept of the condition of the skin, whether fine or coarse, scaly or otherwise. The observations have not been sufficiently extensive for any but a general statement to be made that the presence of roughness appears to affect the quality of the vesicles.

				lbs.
Calves producing	indifferent	vesicles	had an average weight of	274·9
,,	moderate	,,	,,	254·9
,,	good	,,	,,	234·5
,,	very good	,,	,,	236·4

Sex of calves.

The same results have not been obtained equally from male and from female calves. Omitting 2 calves, the vaccination of which failed, 1 in which no statement of the result was given, and 6 which were not vaccinated, we have the following results:—

17·5	per cent.	of the males	had very good vesicles.
21·4	,,	females	,, ,, ,,
31·9	,,	males	good vesicles.
42·9	,,	females	,, ,,
35·1	,,	males	moderate vesicles.
23·8	,,	females	,, ,,
15·4	,,	males	indifferent vesicles.
11·9	,,	females	,, ,,

The experience of the year is slightly in favour of female calves, 64·2 per cent. of the female calves produced "very good" or "good" vesicles, while only 49·4 per cent. of the male calves produced vesicles of this class. The number of female calves vaccinated is, however, too small for any great value to attach to these figures.

From April 11, 1882, to the end of March 1883, 614 children were primarily vaccinated at the station, and 29 re-vaccinations were performed. Of the former, 6 failed, 5 of which were vaccinated directly from the calf, and 1 with stored lymph. All but one were subsequently successfully vaccinated; one of the six was not again vaccinated.

Results obtained from animal and humanized lymph.

The following table shows the success in each hundred of insertions of lymph. The per-centages are calculated upon 576 direct vaccinations with animal lymph, and 34 vaccinations with animal lymph stored in tubes.*

For the purposes of comparison results obtained with humanized lymph in 150 cases of direct vaccination and 34 of vaccinations with lymph stored in tubes at Surrey Chapel are given.

Three operators were concerned in the various vaccinations. Broadly speaking, they were of equal skill, yet each operator had not exactly the same degree of success, and this fact, together with the smallness of the number of cases of vaccination with stored lymph, are reasons for not attaching any great value to the figures, but it is thought well to put them on record.

* Subsequent experiment gives a greater value to calf-lymph stored on points than to that stored in tubes.

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Insertion Success.

	Animal.	Humanized.
Direct	96·3	95·0
Tubes	71·7	57·9

The age of the stored animal-lymph varied from 2 to 270 days. The age of the stored humanized lymph varied from 2 to 141 days.

The average diameter of the vesicles estimated upon the same cases as above is shown in the following table :—

Average Diameter of Vesicles, in Inches.

	Animal.	Humanized.
Direct	·39	·36
Tubes	·31	·28

The average extent of areola estimated on the same cases is shown in the following table :—*

Extent of Areola, in Inches.

	Animal.	Humanized.
Direct	·38	·34
Tubes	·21	·18

These tables will suffice to show that the local effects of inoculation of calf-lymph are practically the same as those produced by humanized lymph, a statement which may also be made concerning the constitutional symptoms produced by the two kinds of lymph.

The same need for care was required in the selection of vesicles for the further cultivation of lymph on the calf, and for the vaccination of children as in the case of arm to arm vaccination with humanized lymph; and from time to time it became necessary for the purpose of maintaining the supply of lymph to revert for the vaccination of a calf to lymph derived from an earlier calf than that immediately antecedent to it.

Of the total number of calves from which children were vaccinated, but six produced lymph which could be regarded as being responsible for a partial failure of the vaccination of children inoculated with it.

In conclusion it may be repeated that judged by the experience gained during the first year's operations at the Animal Vaccine Establishment, animal lymph "takes" with as much certainty as humanized lymph, and produces similar local and constitutional effects.

It only remains for me to state that from April 1, 1882 to March 31, 1883 (both days inclusive), 5,560 charges of calf-lymph have been supplied from this station to the National Vaccine Establishment at the Local Government Board. These have consisted of 4,305 points and 1,255 tubes, collected on the 5th day after vaccination, and transmitted on the day of collection. Each point and each tube is charged with a quantity of lymph, so that two points or one tube are amply sufficient for the vaccination of one individual.

* More recently the amount of areola accompanying direct vaccination with animal-lymph has been much reduced, the average of the last 100 cases has been ·22 of an inch, the average size of the vesicle in the same cases being ·37 of an inch.—July 24, 1883.

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App. A. No. 6.

Abstract of Vaccination Laws in Europe.

No. 6.

Notes prepared from Official Documents as to the Laws regulating Vaccination in European Countries. (1882.)

The following memorandum has been compiled from the official reports and other documents procured for the Local Government Board through the Foreign Office in compliance with the Board's request.

The vaccination laws and their modes of enforcement vary considerably in the different countries of Europe, but provisions for securing the vaccination, and, in some cases the re-vaccination, of children attending schools and of persons engaged in the public services, are almost universal.

Austrian Empire.

(*a.*) *Austria.*

In Austria vaccination is not legally obligatory on the people generally, but is "carried out as far as practicable." On the following classes of persons, however, the operation is compulsory :—

(1.) Wards of State provident institutions.
(2.) Children in orphan houses.
(3.) All persons obtaining scholarships.
(4.) All persons entering charitable institutions.
(5.) All persons to whom free education is granted.
(6.) Candidates for the military educational institute.

There is no special rule as to the vaccination of persons entering the army or navy, but all such persons are medically examined prior to their admission, and where it is doubtful whether the candidate has previously been successfully vaccinated, the operation is performed.

The law regulating the performance of vaccination in Austria was passed in 1836, and has only been altered so far as was necessary to make it compatible with the present system of government.

(*b.*) *Hungary.*

In Hungary vaccination is performed under a law passed in the year 1876. By this law parents and guardians and all persons having charge of children are bound to have them vaccinated within a year of their birth, unless they have had the small-pox. Only vaccinated children are admitted to the military and civil educational institutes.

Belgium.

Vaccination is not compulsory in Belgium. The only legislative enactment of a general character on the subject is a decree of 1818, prescribing measures for extending the system of inoculation of vaccine matter. It is very limited in its action, applying only to certain classes of citizens. Moreover, it does not impose the duty of carrying out its provisions upon the Government, but upon the provincial and communal administrations and charitable institutions. Each province has a special regulation on the subject of vaccination; and the communal administrations can, and in many cases have, established systems for promoting the operation.

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The question of making vaccination compulsory has of late been frequently discussed in Belgium, and the Academy of Medicine, as well as the majority of medical men, advocate legislation in this sense; but up to the present time (June 1881) the Government have taken no steps in the matter.

Denmark.

In Denmark, examinations and quarantine are enforced to prevent small-pox epidemics, and vaccination appears to have been obligatory since 1810.

Re-vaccination is generally not enjoined, but an ordinance of 1836 requires the re-vaccination of all recruits for the army.

France.

In France vaccination is not at present compulsory on the general population, but strict regulations exist requiring its performance on members of the army and navy. The operation is frequently performed by midwives, and the arrangements generally are very defective.

Army.—By an order of 30th June 1848, all recruits whose vaccination marks were doubtful or wanting, had to be vaccinated on joining the army.

This order having been followed by a diminution of small-pox in the army, a further and more stringent order was issued on the 31st December 1857, directing that all recruits should be vaccinated on joining their regiments whether they had been previously vaccinated or not. By this order also, re-vaccination was made compulsory throughout the army.

In 1876 it was found that vaccination and re-vaccination were not sufficiently carried out under the above orders; further regulations were therefore issued on the 1st March 1876 and the 16th June 1877, impressing upon the military authorities the necessity of securing the early performance of the operation.

Navy.—By an order of 30th November 1869, every man is required to be vaccinated within eight days of his joining the navy unless he bears undoubted marks of small-pox. This order has been followed by good results, small-pox being now rare in ships at sea.

German Empire.

In the German empire, prior to 1875, different modes of enforcing vaccination existed, and the stringency of the vaccination laws varied in different states:—

(*a.*) *Baden.*

In the Grand Duchy of Baden vaccination has been compulsory since 1815:—

(*b.*) *Bavaria.*

In the kingdom of Bavaria it was introduced eight years earlier by a royal ordinance of 26th August 1807. Re-vaccination was not compulsory on the general population prior to 1875, but under the police regulations for Bavaria of 1871 re-vaccination could be ordered at any time by the proper authorities as a precaution against the outbreak of small-pox:—

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(c.) *Hesse-Darmstadt.*

In the Grand Duchy of Hesse the practice was also introduced in 1807, but appears not to have been made compulsory until some little time after. Under the law, as it existed in Hesse before 1875, children were usually subjected to vaccination at a much earlier age than they are now, and there were scarcely any refusals to comply with the law:—

(d.) *Saxe-Coburg-Gotha.*

Compulsory vaccination in the Duchies of Saxe Coburg and Gotha dates from the year 1829, and to a certain extent from an earlier period:—

(e.) *Würtemberg.*

Compulsory vaccination was introduced into the kingdom of Würtemberg by a law passed on the 25th June 1818:—

In 1875, however, all the laws for the enforcement of vaccination existing in the different German states were superseded by the Imperial vaccination law passed on the 8th April 1874, which applies to the whole of the German empire. Under this law every child must be vaccinated before the end of the calendar year next following the year in which he or she was born, unless it be proved by medical certificate that the said child has already had the small-pox.

Every pupil of a public or private school has to be vaccinated within the year next following that in which the said pupil has completed his or her 12th year, unless it be proved by a medical certificate that he or she has had the small-pox or been successfully vaccinated within the last five years. If the operation is illegally left undone, the court may fix a time for its performance.

As regards the army and navy, every man on entering either of these services is obliged to be re-vaccinated, even if he already bear marks of successful primary vaccination.

HOLLAND.

In Holland the basis of the existing law relating to vaccination is contained in an Act passed on 4th December 1872. By section 17 of that Act it is provided that "schoolmasters, schoolmistresses or pupils, "who are not in possession of a declaration signed by a physician "setting forth that they have been successfully vaccinated, or vaccinated "more than once, or have had small-pox naturally, shall not be "admitted into schools."

ITALY.

Various laws as to vaccination exist in the different States of Italy, but the operation does not appear to be anywhere directly obligatory. Children, however, are not admitted to the schools and public institutions unless they have been vaccinated or have had the small-pox. There are no general laws or regulations concerning re-vacccination.

In the Italian navy since 1865 the men are vaccinated immediately on their enrolment, whether or not they have previously had the small-pox or been vaccinated. The regulations in the army are the same as those observed in the navy.

MONTENEGRO.

From a despatch dated 11th June 1881 from the Montenegrin Minister for Foreign Affairs, it appears that at that time there was no

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written law regulating vaccination in Montenegro. It was the practice, however, for the Government to send a doctor through the country, or to the chief place of each district, every two or three years, and the people were obliged to bring their children who had not been vaccinated. The Government have recognised the insufficiency of this method and have given directions for the preparation of a general regulation relating to vaccination.

Norway.

In Norway an ordinance of the 3rd April 1810 (*section* 7) provides that children shall not be received into schools except upon production of evidence of their vaccination or of their having had small-pox. The same rule applies to apprentices, to corporations, and to persons received as pensioners in the public institutions, (*section* 8). Soldiers are vaccinated immediately on joining the service unless they produce the "ordained" certificate (*section* 9) or show unmistakeable marks of having had small-pox. Candidates for confirmation who have not been vaccinated or had small-pox are admonished by the clergyman to have the operation at once performed, and since the 1st January, 1811, clergymen have been forbidden to marry any couple unless they prove that they have either been vaccinated or had small-pox (*section* 10).

Sweden.

In Sweden the Act in force is dated 29th September 1853 and requires (*section* 1*a*) the vaccination of all children before they attain the age of two years, unless they have already had small-pox. No person can be admitted into any public school, college, or educational establishment unless he prove vaccination, small-pox, or insusceptibility (*section* 2). No child can be delivered up from any orphan house for education except on production of a certificate of vaccination or small-pox (*section* 3). The clergy are directed to encourage vaccination as much as possible (*section* 13). Penalties are provided for persons who, not being vaccinated, are seized with small-pox (*section* 23*b*, *page* 33).

Roumania.

As regards Roumania, up to the year 1874, primary vacciuation does not appear to have been directly compulsory, though the performance of the operation was indirectly attained by requiring all boys and girls attending schools to give proof of their having been vaccinated. In 1874 a law was passed under which vaccination was made obligatory upon the entire population, and re-vaccination upon children of seven years and upwards.

Servia.

In Servia the present law regulating the performance of vaccination came into operation in May 1881. Every newly-born child is now required to be vaccinated before it attains the age of 12 months (*section* 20 (6*a*)); and every child must be re-vaccinated on completing the course of the elementary schools. (*Ibid.*)

Every recruit must be vaccinated on joining the army whether he shall have previously been vaccinated or not. (*Ibid.*)

Where parents persistently neglect or refuse to have their child vaccinated a heavy fine (4*l.*) is imposed if the child subsequently takes small-pox and the disease spreads.

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When small-pox breaks out in any commune extraordinary attendances of the public vaccinator are at once arranged, and all the inhabistant of the commune can be re-vaccinated, whether they have been previously re-vaccinated or not.

Provisions relating to vaccination similar in theory to the law of 1881 existed before that year, but re-vaccination was not compulsory, and there was no machinery for enforcing the law.

Spain.

In Spain no general enactment relating to vaccination existed before the decree of 30th December 1873, though the Spanish Government have favoured the performance of vaccination since its discovery. The decree referred to does not make the operation obligatory upon the population generally, but only upon individuals who are immediately under the control of the civil authorities in workhouses, colleges, penal establishments, and hospitals, and upon men in the army and navy. The decree, however, directs provincial and municipal authorities to exert what power they may possess in order to oblige all individuals immediately dependent on them to be vaccinated or re-vaccinated, and to propagate the notion of the convenience of vaccination among private individuals.

Switzerland.

The vaccination laws of Switzerland vary in the different cantons. The operation is compulsory in all except Bâle-ville, Uri, Glarus, and Geneva. In Glarus the compulsory clauses were repealed in 1876.

Re-vaccination is generally compulsory in the cantons of Fribourg and the Grisons. In Zurich, Zug, Argovie, and Neuchâtel re-vaccination is compulsory only in infected houses and during an epidemic. In the Soleure Canton the general performance of re-vaccination can be ordered during an epidemic by the sanitary authority. In several other cantons the operation is merely encouraged, and in some no definite regulations on the subject exist.

In 1871 the re-vaccination of all recruits was ordered, and the order was confirmed by a Federal decree passed in 1873.

In 1881 an attempt was made to introduce a general vaccination law which should be applicable to the whole of the Swiss confederation. The bill passed the Federal Chambers, but on reference to the popular vote it was thrown out by a large majority. The old arrangement by which each canton controls its own vaccination laws remains therefore in force. Probably the decision of the people against the Federal law proceeded from the objection of the cantons to transfer their own rights to the Federal government, rather than to any direct objection to compulsory vaccination. Bâle-ville appears to be the only canton which has recently repealed its compulsory vaccination law in consequence of the anti-vaccination movement.

Turkey.

No law exists in Turkey for the regulation of vaccination, but there are certain establishments at which all persons desiring to be vaccinated can have the operation performed. In addition, vaccinators are occasionally sent to the Bosphorus villages to vaccinate all who desire it.

We have no information as to the vaccination laws in Portugal or Russia.

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ABSTRACT of the principal Information contained in the foregoing Memorandum.

Countries.	Vaccination is directly compulsory.	Vaccination is not directly compulsory.	Vaccination is not generally compulsory; but is compulsory						Present Vaccination Law came into Force.	Re-vaccination is Compulsory.	Proportion of Children due for Vaccination, but not Vaccinated at end of Year. (For Period, *see* individual Return.)	—
			In Army.	In Navy.	On Children attending Schools.	Military Educational Establishment.	Children in Orphan Houses.	Persons entering Charitable Institutions or under control of Civil Authority.				
											Average.	
AUSTRIA -	—	1	1	1	1	1	1	1	1836	—	15·2	
HUNGARY -	1	—	—	—	1	1	—	—	1876	—	—	
BELGIUM -	—	1	—	—	—	—	—	—	1818	—	—	Vaccination law not administered by Supreme Government.
DENMARK -	1	—	—	—	—	—	—	—	1871	On army recruits.	—	Vaccination "always obligatory."
FRANCE -	—	1	1	1	—	—	—	—	—	Army and Navy.	33·3	
GERMAN EMPIRE	1	—	—	—	—	—	—	—	1875	Yes	14·3	
HOLLAND -	—	1	—	—	1	—	—	—	1872	—	—	
ITALY - -	—	1	1	1	1	—	—	—	Various.	—	—	
MONTENEGRO -	—	1	—	—	—	—	—	—	No law.	—	—	
NORWAY -	—	1	1	—	1	—	—	1	1810	—	—	Vaccination certificates necessary on marriage.
SWEDEN -	1	—	—	—	—	—	—	—	1853	On recruits	16·1	Penalties on unvaccinated small-pox patients.
PORTUGAL -	No information.											
ROUMANIA -	1	—	—	—	—	—	—	—	1874	Yes	—	
RUSSIA -	No information.											
SERVIA -	1	—	—	—	—	—	—	—	1881	Yes	—	Penalties on unvaccinated small-pox patients.
SPAIN - -	—	1	1	1	—	—	—	1	1874	—	—	
SWITZERLAND -	In all but 4 cantons.	In 4 cantons.	1	—	—	—	—	—	—	In some cantons.	—	
TURKEY -	—	1	—	—	—	—	—	—	—	—	—	

APP. A. No. 6.
Abstract of Vaccination Laws in Europe.

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App. A. No. 7.

On Dr. Cory's Experiments in vaccinating himself from Syphilitic Children.

No. 7.

Report by a Committee appointed to investigate Dr. Cory's Experiments in vaccinating himself from Syphilitic Children.

Dr. Robert Cory, the subject of this inquiry, aged now 38 years, was vaccinated in infancy, re-vaccinated the first time, he states, 22 years ago, and a second time in Germany in 1871 or 1872. There are visible two large, flat, apparently primary vaccination scars, one on each arm, and in addition, on the right arm, three small apparently *re*-vaccination scars.

On four occasions since, he has vaccinated himself, or caused himself to be vaccinated, from obviously syphilitic infants, being on each occasion in his ordinary condition of health. He had never previously suffered from syphilis.

The following are the particulars of these vaccinations, as we have been able to gather them from notes kept by Dr. Cory and from inquiries made by ourselves to the extent that it has been found practicable to make them after the lapse of a varying number of years:—

First Experiment.

This was performed in the year 1877 or 1878, from an infant aged eight months, who had been brought for inspection to the Surrey Chapel Vaccination Station. The infant was regarded by Dr. Cory as unquestionably syphilitic, and was much emaciated; but at the time when the lymph was taken there was no eruption present on the skin, nor was there any other obvious symptom of active syphilis. The lymph was taken on the eighth day, as is customary. The vaccine vesicles were noted as normal in appearance, but delayed in development.

From one of these vesicles Dr. Cory vaccinated himself in one place just above the left wrist. He most carefully avoided, in taking the lymph, so puncturing the vesicle as to obtain lymph containing an admixture with blood; and in fact, had the lymph obviously contained any blood, he would not have used it.

The vaccination was successful; the resultant vesicle attained its height on the fourth or fifth day, and then declined. The inflammation about it was very limited in extent, but the glands in the axilla became tender, although not perceptibly enlarged.

No scar from this vaccination is now discernible.

No syphilitic trouble followed.

Second Experiment.

This was performed on November 5th, 1879.

The vaccinifer was a male infant, aged 85 days, who had been under mercurial treatment for syphilis at St. Thomas's Hospital for about four days when used by Dr. Cory for the purpose of his experiment. At that time there were present on the infant manifestations of active syphilis. There were copper-coloured spots on each cheek, extending over the nose, and small spots round the mouth, which had lasted for three weeks. The child had marked 'snuffles,' which had been present from its birth.

From this infant Dr. Cory vaccinated himself, taking the lymph very carefully so as to avoid any admixture of blood. The vesicles on the

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child's arm were in the eighth day of their development and are noted in the vaccination register as "good vesicles." There were five of them.

This attempt at vaccination was unsuccessful. No pock arose, but on the day after the operation an areola is noted as having been observed; it declined on the third day.

No syphilitic trouble followed.

Third Experiment.

This was performed on May 11th, 1881.

The vaccinifer was a male infant, aged 4½ months, who was attending the out-patient department of St. Thomas's Hospital for syphilis, being under the care of Mr. Anderson. He was, at the time of his vaccination, under mercurial treatment. The following notes of the case were given to Dr. Cory by Mr. Anderson on June 22nd:—"Healthy at birth; at "the age of six weeks attended the hospital for 'hydrocele'; at that time "there were no signs of syphilis. At the age of three months there "was observed a roseolar eruption chiefly about the nates, there were "mucous tubercles about the angles of the mouth, 'snuffling,' emacia-"tion, and a cachetic aspect. The child improved rapidly under the "mercurial treatment. On June 7th, when he attended again for a "spasmodic affection of the muscles of the left knee, he was in a good "condition and free from signs of syphilis; he was then still taking "grey powder."

When Dr. Cory took lymph from this infant on May 11th, the eighth day of the vaccine development, the vesicles are noted to have been of the normal appearance and not inflamed. They are noted as having resembled vesicles in other cases in which grey powder was being taken.

Again Dr. Cory took the lymph with the utmost care to avoid admixture with blood, and with it vaccinated himself in two places at the upper part of the left fore-arm.

On the day following, an areola of about 16 m.m. in extent from the centre was noted around each puncture. It had declined by the evening of that day, and then quickly disappeared. The vaccination was unsuccessful; no pock arose.

No syphilitic trouble followed.

Fourth Experiment.

This was performed on July 6th, 1881, at Dr. Cory's request, by Mr. Haslam, now assistant surgeon to the Birmingham General Hospital.

The vaccinifer was a female infant aged 84 days. The history of the child was that soon after birth she suffered from 'thrush,' from which she recovered completely. Ten days after birth she began to have 'snuffles.' When about four weeks of age an eruption appeared upon the arms, and it was still present when the lymph was taken for Dr. Cory's experiment. In addition, there was at that time a sore upon the right buttock, and a sore also in the left nostril.

At the time Dr. Cory used this vaccinifer there were five vesicles on the arm, and they are described as normal in appearance and not inflamed. The immediate neighbourhood of the vesicles was free from eruption.

Although Mr. Haslam performed the operation on Dr. Cory, Dr. Cory himself took the lymph. An ordinary lancet was used. The

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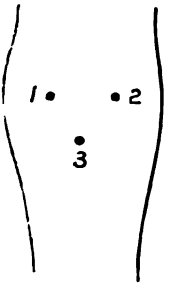
App. A. No. 7.

On Dr. Cory's Experiments in vaccinating himself from Syphilitic Children.

vesicles were shallow, and therefore difficult to prick without drawing blood. The first vesicle which Dr. Cory opened bled, and he therefore abandoned it, and after wiping the lancet clean opened another. This did not bleed, lymph exuded spontaneously, but not in great quantity. It welled up into a bead, and he took it upon the lancet, certainly without pressing the vesicle, and handed the charged lancet to Mr. Haslam. It is certain that the lancet was only charged once; it was not recharged.

With the lancet thus charged Mr. Haslam vaccinated Dr. Cory in three places on the front of the upper part of the left fore-arm. The places were arranged in form of a triangle, two above and one below, thus—



Mr. Haslam cannot recollect the order in which these places were vaccinated, but thinks it probable that the order was that indicated by the figures 1, 2, 3. It is tolerably certain that the lower one was the last of the three.

Dr. Cory states that after he had been vaccinated he took some of the remaining lymph into a tube and preserved it. The lymph was only sufficient in quantity to partially charge the tube.

The day following the operation the three places were red, with small areolæ which were declining the next day; six days later the places were quite healed. The vaccination was unsuccessful. No pock arose.

On the 21st day, viz., on July 26th, Dr. Cory observed that the lower of the three places and the outer one of the upper pair had become red and had each formed a small red papule. These papules grew slowly until August 4th, when the upper one began to desquamate, and when the scab fell from its centre, this appeared slightly moist. From this date to August 8th the papules grew more quickly, especially the upper one, and occasionally a slight areola appeared round each. On August 8th a little yellow spot appeared in the centre of the upper one, and a scab had formed over it by the morning of the 9th. The lower papule was also growing more rapidly.

On August the 11th the centre of the upper spot was covered by a very small scab, which, when removed, revealed a little ulcer. The lower papule was still dry. On this day, during the meeting of the British Medical Association at Ryde, Dr. Cory showed his arm to Dr. Humphry and Mr. Hutchinson, both of whom considered the spots to be syphilitic. At Dr. Cory's request, with the assent of Dr. Humphry and with Mr. Hutchinson's reluctant concurrence, the diseased structures were removed by excision by Dr. Humphry in the presence of Mr. Hutchinson at the Ryde Infirmary, antiseptic precautions being used. The portions excised embraced some adjoining sound skin and they were preserved by Dr. Cory for subsequent microscopical examination. The edges of the wounds were brought together with needles. The next day, the incisions having united, the pins were removed.

On the 14th the lower place was a little inflamed. On the 17th almost all tenderness on pressure over the wound had disappeared, but for the first time a gland was felt in the axilla, not painful on pressure. The antiseptic bandage had not yet been removed. On the 18th, when the wounds were again dressed, they appeared dry. The lower one was inflamed and indurated, and the places where the pins had been

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had sloughed. There was great axillary trouble during the day. On the 20th the pain in the axilla was severe even when resting. Two glands in the axilla were enlarged and one of them was very painful when pressed. Feeling of tightness about the chest. On the 21st felt ill with a peculiar oppression about the sides of the chest and between the shoulders. Axilla with enlarged glands very tender. Antiseptic dressing left off. On the 22nd induration of lower wound less and axillary pain much less. Water dressing. On 23rd upper wound healing; lower one not now indurated; felt ill. On 24th the wounds were doing well, but the pain in axilla was very bad. There was a tender spot in the middle of the sternum. August 25th, commenced taking five grains of blue pill daily; very much less pain in axilla at night. August 26th, sweated much during the night, wetting night-shirt through. August 27th, rheumatic pains, but slept better at night. Upper wound healing rapidly; lower one stationary. Towards evening on 29th throat was very sore, and on 30th glands of the neck were painful, and movements of the head were painful.

On 31st felt better in health, but for the first time noticed roseolar eruption on the forehead and temples, back of neck, and below the ears, and also on lower part of the abdomen. This eruption lasted four days. He now placed himself fully under antisyphilitic treatment.

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1. Dr. Cory has stated to us that the object he had in view in instituting these experiments upon his own person was to test a current belief that vaccine lymph taken from a syphilitic person, if unmixed with the blood of the vaccinifer, does not contain the syphilitic virus, and is incapable of imparting syphilis by its inoculation. Having acquired syphilis at his last experiment, he had (apart from any question of vaccination) a second object in having the primary lesions excised, namely, to examine microscopically the excised parts, and to ascertain whether the excision would prevent constitutional disease or modify its course. It was further in order to give this second experiment fair scope, that he abstained from submitting himself to antisyphilitic treatment until the signs of constitutional syphilis had become so clear, that doubt of the failure of excision as a preventive measure could no longer be entertained.

2. It is conclusively proved by Dr. Cory's experiments that it is possible for syphilis to be communicated in vaccination from a vaccine vesicle on a syphilitic person, notwithstanding that the operation be performed with the utmost care to avoid the admixture with blood.

3. It is to be remarked that the infants from whom Dr. Cory took lymph for his personal vaccination were, in all cases but one, not suffering from hereditary syphilis in a *latent* form, but were infants in whom *active* symptoms were unmistakably present, as shown by cutaneous eruption, snuffles, mucous tubercles, and ulcerations.

4. Moreover, out of the four children thus used, only one was proved to have been capable of imparting syphilis by the lymph taken from its vaccine vesicle.

5. Dr. Cory's case is in conformity with general experience in the following respects, among others; namely, that when syphilis is communicated by inoculation, the first appearance of the disease is at the seat of inoculation, the taint of the blood being in all cases preceded by a conspicuous, peculiar and persistent manifestation of disease at the seat of inoculation.

6. The infants from whom Dr. Cory took lymph for his experiments on his own person, were in such a condition of obvious syphilitic disease

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App. A. No. 7.

On Dr. Cory's Experiments in vaccinating himself from Syphilitic Children.

as would certainly have precluded their use as vaccinifers by even an inconsiderate and reckless vaccinator. Indeed they were selected by Dr. Cory for his self-vaccination because they were unquestionable syphilitic cases. It is a rule of practice in the profession not to use in vaccination lymph taken from a child in whom there is any suspicion whatever of syphilitic taint, or indeed in whom there is any skin disease although of a character known to be harmless; and the observance of this professional rule is strictly enjoined by the Local Government Board in its instructions to public vaccinators through the country.

JOHN S. BRISTOWE.
G. M. HUMPHRY.
JONATHAN HUTCHINSON.
EDWARD BALLARD.

27th July 1883.

NOTE BY THE MEDICAL OFFICER ON THE FOREGOING EXPERIMENTS.

The relation of this case to English vaccination practice needs to be rightly apprehended.

Even before the medical profession admitted that there was any risk of the transmission of syphilis in the act of vaccination, except through the most culpable incompetence or misconduct of the vaccinator, it had laid down for strict observance the practical rule not to use the lymph of an unhealthy person, whatever the nature of the ill-health, for the vaccination of others. Acting upon this rule English vaccinators had in practice taken care to avoid using any syphilitic children as vaccinifers, and it was for a long time impossible to determine whether the absence from English practice of authentic cases of children receiving syphilis in vaccination was to be attributed to this care or to an abstract impossibility to communicate syphilis in the operation of vaccination.* And when at last it did appear that syphilis had been transmitted in vaccination, the study which it was desired to make of the circumstances under which the thing could occur was hindered by the extreme rarity of its occurrence.

By the operation of this rule of practice, insisted on by all practising vaccinators, the pathologist found himself deprived of opportunities for observing cases of syphilis transmitted in vaccination, and with this position of the question Dr. Cory was not satisfied. Should he, because, in the course of an obedience to the practical rule, he had never seen a case of syphilis among children vaccinated by him, and had never been able to see one in the practice of others, be content to know that the thing was possible, and not to understand the way of its possible occurrence? Here his scientific zeal came to the front. His object of learning would be gained, he reasoned, only if he could observe a duly devised experiment; and he had but himself to experiment on.

In the outcome, Dr. Cory's result has a certain pathological interest. The lymph of a vaccine vesicle upon an actively syphilitic child may, it would appear (though under limited conditions that remain obscure) contain the virus of syphilis even when there is no recognised ad-

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* See Simon, in Papers relating to the History and Practice of Vaccination, 1857, pp. lxiii. and lxxxi., and in Twelfth Report (for 1869) of the Medical Officer of the Privy Council, pp. 39–45; also Seaton on Vaccination, 1868, pp. 307 and 338; also Marson, Report of Select Committee 1867, Qu. 4229, 4249; Trousseau, Lectures on Clinical Medicine, 1869, Syd. Soc. Ed. Vol. II., p. 125; Ballard, Essay on Vaccination, 1868, pp. 355 and 360.

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On Dr. Cory's Experiments in vaccinating himself from Syphilitic Children.

mixture with the lymph of matters foreign to it. But that is all. For it was needful for the purpose of Dr. Cory's experiments that he should throw aside two rules which habitually guide him as they guide other people in the practice of vaccination. He had to take, and he did take, intentionally, lymph from children with strongly marked manifestations of syphilis, one of which manifestations was a pronounced skin disease. This abandonment of vaccination rules would appear furthermore to have been of the essence of his success in transmitting syphilis.

Dr. Cory's result, therefore, does not give any new rule for the guidance of the practitioner. For the practising vaccinator the obligation will remain, neither weakened nor strengthened, to "Take lymph only from subjects who are in good health"; and "Always carefully "examine the subject as to any existing skin disease and especially as to "any signs of hereditary syphilis." (Board's Instructions to public vaccinators.) And the result of Dr. Cory's experiment, in which this rule of practice was necessarily disregarded, does not at all affect the conclusion derived from long continued experience of properly conducted vaccinations, that the observance of the above rule is in practice a sufficient safeguard against the transmission of syphilis.

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App. A. No. 8.

On Diphtheria in Pirbright; by Mr. Power.

No. 8.

On Diphtheria in Pirbright, and on the Influence of the School there in the Behaviour of the Disease; by Mr. W. H. Power.

This inquiry was instituted under circumstances as follows:—

On the 27th November 1882 the Guildford Rural Sanitary Authority applied to the Board through its Health Officer, Mr. Joseph Smith, for advice respecting diphtheria prevalence in Pirbright that was regarded as having had relation with the operations of the National School there. Mr. Smith stated that since May last this school had on several separate occasions been closed, and each time for several weeks, on account of diphtheria among the scholars; and that diphtheria in the parish having undergone diminution or cessation during each interval of school closure, reappeared, and mainly among school children, each time that the school recommenced operations. Upon this evidence the Board directed the present investigation into the conditions of diphtheria prevalence in Pirbright.

The parish of Pirbright is situated 4–6 miles from Guildford town, at the extreme north-west of the rural district. Except to the eastward it is coterminous with parishes in the Chertsey and Farnham districts. Geologically, it is wholly on the sands and loam of the Upper and Middle Bagshot beds, the land being poor and little cultivated, consisting largely of heath and common. Notwithstanding its sandy nature, the soil cannot be regarded as dry, water being commonly held up near the surface by an impervious stratum: the water is mostly impregnated with iron. The population of the parish is almost wholly of the labouring class, and it is essentially a scattered population. Near to the church on the east of the parish there is some considerable aggregation of dwellings constituting the "village." Here 30–40 houses are spread for several hundred yards along two converging highways, on one side only of each highway. Again, at Dawney's Hill, north of the village, and about ¼ mile distant, is another and smaller group of cottages near the national school. But generally the houses of Pirbright, occurring singly or in very small groups, are dispersed over several miles of country. The sanitary circumstances of the parish may be deemed above the average. Few dwellings are overcrowded, and almost without exception they have garden ground or other ample space about them. This, while sufficing for utilization (in each instance on the premises) of slop drainage and privy contents, has generally admitted of the tolerably safe disposition of the pit privy in reference to the dwelling and to the surface well which exists in most gardens. Recently the sanitary authority by adoption of watertight tanks for the collection and storage (in each instance away from the house) of slop refuse, has still further diminished risk to surface wells—such as had before arisen by careless people casting foul slops on the ground near to wells. These matters have a bearing on the subject of inquiry as tending to show that there is not in the physical and sanitary circumstances of Pirbright any ready explanation of the diphtheria: that, for instance, from the wide dispersion of dwellings, households have had, for the most part, but little intercommunication, while as regards other sanitary circumstances, they are commonly exceptionally distinct and separate one from another.

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Upon becoming associated with Mr. Smith, I quickly learned that, in addition to definite diphtheria, there had been in the parish a large prevalence of sore throat, much of which had not come under medical observation, and that commonly persons who had had what they or their parents regarded as trivial sore throat, suffered later on from paralyses of the sort that are apt to follow diphtheria. This had been specially noticeable in regard of school children, and Mr. Hill, the schoolmaster, was able to cite many children (some not known to have been ill at all) who, on their reappearance at school after one or another of the intervals of school closure, could hardly see large print, or had difficulty in articulating intelligibly. It became obvious, therefore, that inquiry would be incomplete that did not, beside diphtheria, take account of minor sore throat, and that a house-to-house inquiry was requisite for ascertaining more precisely what had been occurring in the parish. This was accordingly undertaken, and has included almost all the houses in the place, and, in addition, some half dozen houses that, although in other parishes, belonged geographically to Pirbright. This census sought information as to circumstances of escape as well as those of attack, and it therefore took account of the inmates of each house, their several ages, whether or not they had suffered illness, and got together full particulars of the date of attack, gravity of illness, school attendance, and the like, of individuals suffering from diphtheria or sore throat. Inquiry of this had not proceeded far before it became evident that children had suffered disproportionably to other persons, and that the diphtheria which had largely prevailed in the parish in May and April had had its beginning there in March, February, or even January. Special investigation of the circumstances of the earliest sufferers sufficed to show that useful information respecting the origin of the disease was not now to be had. The first cases could not be satisfactorily accounted for. Nothing in the sanitary circumstances of their houses served to explain them; moreover, they were widely separated, and their families, seemingly, were not acquainted with each other. This much may, however, be said: the residences of some of the earliest cases were in the northern part of the district which adjoins Chertsey Union, where, and notably at Bisley, a very short distance from Pirbright, diphtheria had prevailed at the end of 1881 and at the beginning of 1882. Upon the whole it was likely that the Pirbright outbreak had been related, in a fashion that had become obscured, to the Bisley diphtheria; but however this may have been, all that now seemed feasible was examination of the conditions of extension of the disease in Pirbright. This, in view of the special incidence on children, has been mainly inquiry as to the part played by the school in the spread of diphtheria.

The broad results so far of my inquiry are summarised in Table I. It gives for each of nine periods the circumstances of Pirbright school (whether open or closed), and the incidence of diphtheria and sore throat on houses and on persons at different ages in the parish.

The term diphtheria in that Table includes all cases so designated by the medical man in attendance, and as well cases of sore throat which inquiry showed had been followed by sequelæ, such as are commonly associated with diphtheria. Sore throat, on the other hand, is used to denote sore throat not followed by paralysis, but occurring for the most part in families invaded by definite diphtheria. Henceforward, in this report it will be convenient to include both diphtheria and sore throat under the one term "throat illness."

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TABLE I.

Period.*	Pirbright School open or closed.	Houses newly invaded.	Persons attacked.				Total Cases.	Cases afterwards fatal.
			Children under 15 years.		Other Persons.			
			Diphtheria.	Sore Throat.	Diphtheria.	Sore Throat.		
1 January to 1 April (13 weeks.)	Open - -	4	6	2	—	—	8	—
1 April to 20 May - (7 weeks.)	Open - - (Closed 16 May.)	14	23	6	3	3	35	3
20 May to 1 July - (6 weeks.)	Closed - - (Reopened 27 June.)	9	11	3	4	3	21	1
1 July to 22 July - (3 weeks.)	Open - - (Closed 13 July.)	7	9	2	1	—	12	3
22 July to 2 Sept. - (6 weeks.)	Closed - - (Reopened 28 August.)	3	1	1	3	3	8	—
2 Sept. to 30 Sept. - (4 weeks.)	Open - - (Closed 26 Sept.)	6	4	1	2	—	7	1
30 Sept. to 11 Nov. (6 weeks.)	Closed - - (Reopened 6 Nov.)	4	1	1	2	—	4	—
11 Nov. to 25 Nov. (2 weeks.)	Open - - (Closed 21 Nov.)	3	3	1	—	—	4	—
25 Nov. to end of Dec. (5 weeks.)	Closed - -	2	—	2	2	3	7	—
52 weeks.	—	52	58	19	17	12	106	9

* Calendar weeks are here taken in each instance to the end of the week in which the change noted in Column 2 was made.

Two points of interest are developed by this Table I., viz., the distribution of throat illness in time and its incidence on children.

As to time. Passing over the first period, during which diphtheria was acquiring a hold on the parish, we come to compare the seven weeks ending May 20, during which the school was open, with the following period of six weeks (ending July 1) during which it was closed. The weekly number of attacks declined between the two periods; and declined only among children under 15 years old. The school was now re-opened for three weeks, and in that period the weekly attacks became again more numerous, becoming so solely among children under 15. The school being again closed for six weeks, the weekly attacks among children fell almost to the point of disappearance of the disease among them, but new cases occurred among older persons. During the last four months of the year, the school has been twice again opened and twice again closed, with some corresponding fluctuations (smaller in actual amounts) in the appearance of the disease, suggesting a relation between the work of the school and the occurrence of the throat illness, and between the suspension of the school work and the disappearance of the throat illness. Upon the whole, the facts thus far by no means exclude influence of the school on the later behaviour of throat illness in the parish, though they admit of a suspicion that school influence may have been subordinate to some other and more general influence operating through the parish, alike in kind though different in degree, upon children and on other persons.

The incidence of the throat illness on children under 15 years seen in the table is striking, and for the reason that "children under 15"

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includes all children habitually attending school, may seem hardly to require us to hesitate about connecting the disease with the school. Indeed upon very similar evidence schools have, ere now, been believed to have been the sole propagators of diphtheria. But diphtheria, as is now well known, is notably prone to attack children, and especially children at ages 3–15, which are beyond all others the school-going ages. Such children are, in point of fact, far more susceptible of the disease than babies and older persons. Hence evidence of the above sort is not by itself of much value as proving school influence in dissemination of the disease.

Accordingly, in the present instance, the incidence of the throat illness upon children has been studied in considerable detail in the houses of the parish, with the result of finding as usual large immunity from the disease of babies under three years; and much time has been spent in attempting to differentiate between mere age influence at ages 3–15 years, and any influence that may have been special to the school. Especially has information been sought as to whether among certain divisions of the parish (made for the purpose of this inquiry, all of which sent many children to school) there had been any notable differences in the local incidence of the disease on children at 3–15 such as might serve as a starting point for further inquiry. But no such differences have been found.* Throat illness, so far as such children have been concerned, seems to have affected all divisions of the parish pretty uniformly, and at much the same time, nor are there any notable differences in the duration of the prevalence of the disease in the several sub-divisions. These facts are shown in Table II., where the incidence of throat illness per cent. of each class referred to is printed in italics.

Accepting, then, as a fact that a special incidence of throat illness on children at the more susceptible ages in Pirbright has uniformly obtained throughout the parish, the question arises, how far has this been due to mere age as conducing to attack, and how far to difference of exposure, whether at school or elsewhere, of such children to a cause of diphtheria? For answer to this question a standard of comparison is wanted, and that afforded by the behaviour of throat illness toward *persons of various ages in the families that had become invaded* may perhaps suffice. In 50 such families in Pirbright, there were, exclusive of the first sufferers, 251 persons living in the presence of diphtheria subsequent to its introduction into the house; so far as the disease may have had its origin on the premises, exposed to such influences as may have caused the disease in the original sufferers; so far as the disease is infectious, living in the same room, sleeping in the same or in the next room; parents nursing children, children tending one another, all presumably under circumstances of free and sustained exposure to the infection of the disease. Among these 251 persons there were—

Living at ages	0–3	22,	of whom	2	were attacked, or	9·0 per cent.
,,	3–12	59,	,,	23	,,	38·8 ,,
,,	12–15	22,	,,	7	,,	31·8 ,,
,,	over 15	148,	,,	20	,,	13·5 ,,

So that under the circumstances of these families actually invaded, children at ages 3–15 suffered three or four times more than babies and older persons, and children 3–12 to a somewhat greater extent than other children.

* Amongst the several groups thus formed of children 3–15 years old, there were, as regards children at the more advanced age of 12–15 years, certain obvious differences of incidence of throat illness (*see* Table II.); but the numbers dealt with, in each instance were so few as to be altogether untrustworthy.

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TABLE II.

Locality.	Bearing with reference to Village.	Distance from Village.	Houses.		Persons, all Ages.		Persons at Ages:—									
							0–3		3–12		12–15		15–20		20+	
			Total.	Invaded and Dates.	Total.	Attacked.	Total.	Attacked.	Total.	Attacked.	Total.	Attacked.	Total.	Attacked.	Total.	Attacked.
		Miles.														
Village	—	—	36	March 2, May 1, July 2, Aug. 1, Sept. 3, Oct. 1 — 10 *27·7*	160	23 *13·7*	14	1 *7·1*	28	13 *46·4*	7	2 *28·5*	24	3 *12·5*	87	3 *3·4*
Dawney's or Boro' Hill.	N.	½	17	Feb. 1, April 1, June 2, Sept. 2, Nov. 3 — 9 *52·9*	74	19 *27·0*	5	1 *20·0*	25	10 *40·0*	5	3 *60·0*	2	1 *50·0*	37	4 *10·8*
West Heath	N.W.	½–¾	16	May 3, June 1, July 1, Aug. 1, Sept. 1, Oct. 1 — 8 *50·0*	87	16 *18·3*	12	1 *8·3*	20	9 *45·0*	3	1 *33·3*	8	2 *25·0*	44	3 *6·8*
Cowshot and Frimley.	N.W.	1-2½	18	Jan. 1, April 1, May 2, July 1 — 5 *30·0*	92	15 *16·3*	6	— *0·0*	22	10 *45·4*	8	2 *25·0*	8	1 *12·5*	48	2 *4·1*
Duchies	S.W.	1-3	28	April 2, May 3, June 2, Nov. 1, Dec. 1 — 9 *32·1*	121	16 *13·2*	11	— *0·0*	25	9 *36·0*	10	3 *30·0*	9	— *0·0*	66	4 *6·0*
Collins Green and Hogley.	S. & S.E.	½–2	29	April 1, May 1, June 3, July 3, Aug. 1, Nov. 1, Dec. 1 — 11 *37·9*	156	18 *11·5*	4	— *0·0*	28	10 *35·7*	13	2 *15·3*	27	3 *11·1*	84	3 *3.5*
Whole Parish	—	—	144	Jan. 1, Feb. 1, March 2, April 5, May 10, June 8, July 7, Aug. 3, Sept. 6, Oct. 2, Nov. 5, Dec. 2 — 52 *36·1*	690	106 *15·3*	52	3 *5·7*	148	61 *41·2*	46	13 *28·9*	78	10 *12·8*	366	19 *5·1*

These several per-centages 9, 38, 32, and 13½, may be taken as expressing the relative proclivities to throat illness of one and another age-period, under *equal* circumstances of exposure; and we are now in a position to consider the relative incidences actually observed in persons of one and another age under circumstances of life in non-infected houses in Pirbright; and to examine the indications that may appear whether children at ages 3–15 have or have not been exceptionally exposed to the operation of the causes of throat illness. Obviously in proceeding to this examination we have to take account solely of *first*

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attacks in families and of no subsequent attacks. Now in Pirbright there were persons living—

At ages	0–3	52, of whom	1	was a first sufferer.
„	3–12	148, „	37	were first sufferers.
„	12–15	46, „	5	„
„	over 15	444, „	9	„

And the several percentages on these ages were 1·8, 25, 10·8, and 2. Thus, while a throat illness was but seldom introduced into the family by the baby or by the grown-up members of the family, it was brought by the child of 3–12 not very much less often than it would have been brought if the child had been living in an atmosphere of persons infected by throat illness. And this difference between the child of 3–12 and other persons is found, after all due allowance has been made for the differing susceptibility of various ages to contract the illness. The child of 3–12 years, therefore, has for some reason or other apart from its age been the child to get the disease and to take it home to the family that has hitherto been free from it. The next question to be decided is, what has been the influence specially affecting children of this age.

This special influence can hardly have been other than some condition or conditions involved in the process of school going. For, as has already been shown, all parts of the parish have alike been affected by throat illness, and this mainly in the persons of their children, and the several parts have had few conditions in common except it has been school attendance; moreover, in each division of the parish the speciality of the incidence of throat illness has been on children 3–12, which are the chief school-going ages; infants under 3 years not having attended school at all, while children above 12 and under 15 years have attended in small numbers and less uniformly. No doubt enough has been made out to show in a general sort of way school influence; nevertheless, it has been thought desirable to examine the question further, and in some detail, with a view of learning more precisely what has been the value of school influence in determining the results observed. To this end, by help of the schoolmaster, Mr. Hill, note has been made in regard of each period of school operations of the school attendance of each child in the parish; and the incidence of throat illness on children 3–12 at school and not at school, and on other persons, has been studied in each period of the school operations. Similarly, the facts of incidence of throat illness have been studied for each period of school closure. For it was seen that the total influences causative of throat illness, though they might be a diminishing, were probably a varying quantity; and that in successive periods, the total children, and as well other persons, not yet attacked, was a gradually diminishing number. So also it was seen that not only did the number of children at school and not at school vary in different periods of school operations, but that it varied also, according as school was open or closed, within totally different limits; for instance, children (speaking only of children not yet having undergone attack) at school might in separate periods be nil or they might number 100, while children not at school were rarely below 40, but could in periods of school closure be above 100. In making investigation on the above lines, regard was had to the necessity for distinguishing between first sufferers and after sufferers of their families, when estimating school or other influences; and in order that the school should not be unduly credited with cases that might possibly have got their infection just before school reopened, some slight re-arrangements of the groups of weeks constituting the several periods was adopted. The result is embodied in Table III. where rates are, as before, printed in italics.

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Table III.

Periods.	Pirbright School.	Children at Ages 3–12.									Other Persons.			
			At School.				Not at School.							
		Children not recently attacked at beginning of period.	Total not recently attacked.	Newly attacked.	First Cases in their Families.	Secondary Cases in their Families.	Total not recently attacked.	Newly attacked.	First Cases in their Families.	Secondary Cases in their Families.	Total not recently attacked.	Newly attacked.	First Cases in their Families.	After Cases.
January to 27 May. (*21 weeks.*)	Open - (closed 16 May.)	148	96	28	16 *16·6*	12	52	6	2 *3·8*	4	496	17	1 *0·2*	16
27 May to 8 July. (*6 weeks.*)	Closed - (reopened 27 June.)	114	–	–	–	–	114	12	9 *7·8*	3	479	7	2 *0·4*	5
8 July to 22 July. (*2 weeks.*)	Open - (closed 13 July.)	102	62 *[6]	5	3 *4·8*	2	34	–	– *0·0*	–	472	1	1 *0·2*	–
22 July to 9 September. (*7 weeks.*)	Closed - (reopened 28 August.)	97	–	–	–	–	97	2	–	2	471	6	3 *0·6*	3
9 September to 7 October. (*4 weeks.*)	Open - (closed 26September)	95	56	4	4 *7·1*	–	39	1	1 *2·5*	–	465	2	1 *0·2*	1
7 October to 11 November. (*5 weeks.*)	Closed - (reopened 6 November.)	90	–	–	–	–	90	–	–	–	463	4	4 *0·8*	–
11 November to 2 December. (*3 weeks.*)	Open - (closed 21November.)	90	48	3	2 *4·1*	1	42	–	– *0·0*	–	459	4	2 *0·4*	2
2 December to end of December. (*4 weeks.*)	Closed -	90	–	–	–	–	90	–	–	–	455	4	1 *0·2*	3

* The figure 6 in brackets are children regarded for present purposes as having got infected in the preceding period of school closure, though they were taken ill while attending school at the end of June or beginning of July. Hence 6 has been subtracted from 68, and the rate for this period of school operations has been taken on the remaining 62.

The facts of this table, in their general bearing, accord with those of Table I. so far as they admit a probability that school influence has not been the only influence causative of throat illness in Pirbright. But seemingly it has had a larger share in the throat illness, at any rate in the attack of children at later periods of the epidemic, than from Table I. appeared likely. For Table III. shows that attacks of throat illness at ages 3–12, occurring among such children first of their respective families, were in two ways related to school. In uninfected families, children of this age who at a given period were attending school, became affected by throat illness five or six times as numerously as children of the same age who at the same period were not attending school. And this was observed on every occasion when the school was open and the opportunity for comparing the two existed. While the school remained open in the early months of the year, the rate of attack in children 3–12, presumably susceptible of diphtheria but not having the disease at home, was 16·6 per cent. of those who were at school, 3·8 per cent. of those who were not. The next time the school was open, the respective rates were 4·8 and 0·0; the third time, 7·1 and 2·5; and, on the November occasion, 4·1 and 0·0. The numbers upon which these percentages are based are indeed small, but on the other hand the indication which they furnish is too uniform to be mistaken.

Going into the facts of Table III., with the object of stating the incidence of throat illness in the given group of children at periods when the school was open in comparison with periods when it was closed, it is found that comparative statement is not to be made numerically:—

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The periods in question were not of similar length; the children who stayed at home only because the school was closed, taken with the children who never went to school at all, made up a variable which did not lend itself to examination; while the watchfulness for cases of minor throat illness, exercised by teachers when the school was open and wanting at periods of school closure, introduced a further variable that interfered with comparison of total throat illness at one and the other time. Thus during my inspection it would happen that illnesses learnt through school records were not remembered by parents, until some school recorded fact was brought to their recollection. Fortunately there was no example of this last kind to vitiate comparisons invited by the table which follows.

Such facts of Table III., however, as are concerned in the above comparison, admit of being stated in the form of a new table. Accordingly, I show in Table IV., what was the occurrence of throat illness among this particular class of the Pirbright community—children, aged 3–12, who had no infection at their own homes—during periods of school closure and school work respectively. In this table, by omission of the first period of regular school operations (for reasons that will be readily apparent), seven periods, each of a few weeks, come under review; and sufficiently valid comparison may be made between the four periods when the school was closed and the three periods when it was tentatively re-opened.

TABLE IV.—SHOWING in regard of periods of school closure and of school operations subsequent to culmination of the outbreak, the facts as to ascertained occurrence of first attacks of throat illness among children in Pirbright at ages 3–12 years.

Limits and Duration of Period.	Operations of School.	Children 3-12 (first sufferers of their families) attacked in the several periods.		
		Age and Date of Attack.	Nature of Illness and Result.	School Attendance.
May 17th to June 26th (41 days.)	Closed	5 years, May 26	Diph. slight, recovered	Never to Pirbright School.
		4 years, June 10	Diph. slight „	„ „
		4 years, June 11	Diph. „	Never to School.
		11 years, June 13	Diph. severe „	Not to school since 16 May.
		3 years, June 23	Scarlatinal diph. „	Never to school.
June 27th to July 13th (17 days).	Open	11 years, June 29	Diph., died	To school until 2 July.
		6 years, June end	Sore throat, recovered	To school until ill.
		10 years, July 4	„ „	„ „
		4 years, July 6	Diph., died	„ „
		7 years, July 7	Diph., died	„ „
		7 years, July 13	Diph., died	„ „
		6 years, July 15	Diph. slight, recovered	„ until 13 July.
		6 years, July 15	„ „	„ „
July 14th to August 27th (45 days).	Closed	—	—	—
August 28th to September 26th (30 days).	Open	5 years, Sept. 18*	Diph. very slight, recovered.	Not to school since mid. July.
		7 years, Sept. 21	Diph. died	To school until ill.
		5 years, Sept. 23	Diph. slight, recovered	„ „
		5 years, Sept. 24	Throat illness „	„ „
		9 years, Sept. 25	Diph. very slight „	„ „
September 27th to November 5th (40 days).	Closed	—	—	—
November 6th to November 21st (16 days).	Open	7 years, Nov. 12	Diph., recovered	To school until ill.
		6 years, Nov. 14	Diph., „	„ „
November 22nd to December 31st (40 days).	Closed	—	—	—

* This was an only child, aged 5 years, living in the village. She had not been at all to school since mid July, and no cause could be assigned for her illness. Nor could any association of later cases with this child be established, such, for instance, as might help to explain their subsequent attack.

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In view of the above facts, no doubt can be entertained that the conditions of school attendance have played an important part in the speciality of the incidence of grave illness on children 3-12 in Pirbright. It is not of course intended to say that the school influence was the only factor of throat illness at that age; there may perfectly well have been some other factor operating for a while over the whole district, and upon persons of all ages.

There remains for special consideration the question,—in what has school influence consisted?

Two sets of school conditions may be thought of as competent for the results observed:—(1.) General conditions, physical or sanitary, of the school building or of its neighbourhood, and belonging therefore to the school or to the locality of the school; and (2.) Circumstances personal to children attending school, and contributed or conveyed therefore to the school by the children themselves. And in either case be it noted the speciality of operation on children might have been subordinate to some other and original fact of diphtheria.

I. The physical and sanitary circumstances of the school and of the school locality seem to demand special notice inasmuch as they comprise a variety of conditions (all of which have before now been regarded as competent for diphtheria production) that might possibly be in some sort differentiated from like circumstances in other parts of the parish. And any differentiation of a decided sort between such circumstances in and about the school, and in other localities of the parish, might be of importance as tending to explain not only the circumstance of the outbreak having begun upon children, but the sustained incidence also of the throat illness on children attending at the school. But nothing definite in this sense has been made out. The school is a modern building in the erection of which unusual forethought seems to have been exercised. It stands alone on a sand eminence, and is distinct in its sanitary circumstances from the houses of the locality in which it is placed. The slop drainage of the master's house, and of the school lavatories is drained away to a cesspool in a garden many yards distant from the school, and no part of the interior of the building has connexion with this drain; all sink and lavatory pipes are conveyed outside and terminated over trapped drain inlets. Excrement disposal is by earth pails, which are well kept. Up to last May the children's closets were at the back of the lavatory outbuilding adjoining the school; but on occurrence of diphtheria they were, for additional safety, removed to the further side of the playground. The well which is in the master's back yard seems exceptionally safely placed and cared for. Thus it appears that in all the matters referred to, school conditions have differed from other conditions of like sort in the parish only in being better ordered and administered. And therefore it is difficult to believe that anything in the sanitary circumstances of the school can have had any essential part in the production and maintenance of throat illness among the scholars. Nor did I get any suggestion of relation of food or dress or washing to the prevalent disease. So, too, with reference to the sanitary circumstances of the locality (Dawney's Hill, of Table II.) in which the school is situate, there is nothing at all suggestive of relation between matters of this sort and the diphtheria. They differ in no essential particular from those of other localities into which the parish has been divided; and, except in the matter of a common atmosphere, there can hardly have been community of condition for the school and for houses in its neighbourhood. Nevertheless, it has to be noted as at least singular that this Dawney's Hill locality has suffered from

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throat illness and diphtheria to a greater extent and for a longer time than other localities, and that five-ninths of its first sufferers had not at the date of their seizure recently attended the school.

II. Among conditions causative of throat illness that may have been contributed to the schools by the children themselves, personal infectiveness of children attending the schools is the only one which past experience would suggest for consideration. This, if it could be affirmed for each period of school operations, would, in view of the undoubted communicability of diphtheritic disease, go far to explain what has occurred among school children; and the question therefore arises how far can personal infectiveness have operated at the school.

In attempting an answer, we may first think of the school at a time of re-opening after having been closed on account of sickness. Generally, during such periods of school closure, much care was exercised toward effectually getting rid of infection. Not only was the school building and its contents thoroughly cleansed and fumigated, but disinfection of dwellings and clothing of persons that had been attacked was diligently practised in all instances. And on each occasion of re-assembly of the school (and re-assembly of the school was not permitted until no diphtheria had for several weeks occurred in the parish), children that had suffered were excluded until they could be pronounced completely recovered from their throat affection. Then, as regards times of active school work, so far as diphtheria and graver throat illness are concerned, it is not likely that convalescent children did in fact so return to school with their original infection about them as to give disease to fresh children; and more particular examination of the school records, with the inquiry of the parents, suffices to prove that few, if any, persons suffering from diphtheria or notable throat illness did so attend within five or six weeks of their seizure. Unless, therefore, persons afflicted by diphtheritic neuroses are to be regarded as infective, it may be doubted whether diphtheria infection has again and again been introduced to the school by children convalescent from that disease. In the third place, the evidence as to possible introduction to the school of infection by children incubating or developing diphtheria is on the whole negative. Perhaps this may have occurred in the July period, when a girl, regarded as attacked 29 June, two days after re-assembly of school, continued to attend school until 2 July; it is, however, doubtful. This child, although indisposed as early as 29 June, did not have, it is confidently affirmed, any sore throat at all until 3 July, and there is ground for believing this to have been the true date of beginning of her fatal illness. If this may be believed, then, in this instance as on other occasions of re-assembly of school, the diphtheria seizures occurred so nearly together that the existence of a cause common to the several cases would account for the early July attacks even better than a hypothesis that one case had been derived from the other.

But even if we should assume that infection from case to case by diphtheria did really take place on each occasion of resumption of school operations, an important question remains wholly unanswered. On none of these occasions, be it observed, is diphtheria or grave throat illness recognised as having occurred among children in Pirbright for some weeks before re-opening of the schools, and such illness, if it had occurred, could hardly have escaped notice. Yet, no sooner does school re-assemble than diphtheria, and commonly fatal diphtheria, re-appears among school children. Whence, then, came on each occasion of re-assembly of school, the assumed initiatory case of diphtheria? If arising by personal infection, from whom did this first case take the disease?

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And if not from an antecedent case of diphtheria, by what sort of case did this sufferer get infected?

Apparently, there is no sufficient answer to these questions in considerations arising from what has been noted elsewhere, viz., that trivial sore throat may, by what has been termed a process of "progressive infectiveness" operating through several individuals successively, give rise ultimately in other persons to attacks of true diphtheria. At Pirbright it is likely enough that trivial sore throats designable as "cold," though few can now be heard of, existed among children on each occasion of their re-assembly at school, but there is no evidence of progressively increasing gravity of the earlier cases, if indeed there was time for the process. On the contrary, with startling suddenness, multiple cases of diphtheria, and fatal diphtheria, promptly occurred on each occasion of re-opening the school; and cases intermediate in gravity between these diphtheria cases and the "colds" that on the above hypothesis gave rise to them, are not, except perhaps in the July period, to be found. No satisfactory explanation of this behaviour of the diphtheria is forthcoming.

This investigation has failed, therefore, in giving definite reply to the main question as to the nature of the school influence. Nor can any beyond speculative answers be made to other questions that may be thought of as arising from it. As for instance:—How far and in what direction would the later behaviour of diphtheria in Pirbright have been modified had the school been closed in the first instance at an earlier date? and again, What would have happened if the school had not been closed at all?

In bringing this report to a conclusion, mention may be made of certain facts in the natural history of diphtheria that came under notice during this inquiry. These, though they may not be new, have interest in regard of the story that has been told. In our investigation of the incidence of throat illness upon families, Mr. Smith and I were struck, and independently of one another, by the apparently different ability of the disease in one and another instance to extend itself in families invaded. Not unfrequently severe and fatal diphtheria appeared destitute or well-nigh destitute of power to infect other children living along with it, while on the other hand cases of very trivial sore throat or "colds" that were not perhaps heard of (except by close questioning) often preceded and were seemingly responsible for after-occurrences of true and fatal diphtheria in the family. Especially was this apparent capacity of mere sore throat for breeding malignant diphtheria noticeable in regard of families comprising many young children. In such families severe or fatal cases of diphtheria tended to occupy a position midway in a series of attacks that began as sore throat and ended in similar fashion. And further, we got a suspicion, though the instances were too few to justify any conclusion thereon, that, given the occurrence about the same time of two or more cases of trivial sore throat among children of a large family, such occurrence was likely to be quickly followed by severe diphtheria attack in one or more children of that family. This suspicion may like enough be hereafter proved invalid; it is only noteworthy as having arisen before the facts as to the behaviour of diphtheria in that larger family, Pirbright School, had been got together and formulated.

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No. 9.

REPORT by Mr. W. H. POWER, on an OUTBREAK, in certain DISTRICTS of LONDON, of SCARLATINA believed to have been distributed in MILK: with POSTSCRIPT recording certain Experiments by DR. KLEIN, F.R.S.

In a letter dated 2nd February 1882 the clerk to the St. Pancras Vestry reported an outbreak of scarlatina in the southern part of that parish, and he stated that inquiry by the Vestry's sanitary department tended to show that the disease was traceable to the milk service of a particular dairy business situated in the neighbouring district of St. Giles, and getting its milk supply from a certain farm near Farnham in Surrey. Further, and on behalf of his Authority, the clerk requested that the Board would institute inquiry respecting the circumstances of the farm whence the implicated milk had been derived. Accordingly I was instructed by the Board to confer with the Health Officers of St. Pancras and St. Giles with a view of getting information respecting the outbreak and the circumstances which had appeared to connect it with the particular milk supply. Afterward, in the event of a relation becoming apparent between milk and the outbreak of scarlatina, I was to set myself to find out the source of infection of the milk.

In the following pages I propose to tell briefly the history of the outbreak, using, in addition to materials collected by myself, observations made for St. Pancras and St. Giles by the health officers of those districts before my inquiry commenced and afterwards in aid of my inquiry; and for other districts of London, availing myself of the assistance given me by their health officers. I propose subsequently to give an account of my inquiries at the milk farm and to pass on to some general considerations that appear to be of importance.

On the 14th January and following days there occurred a sudden and extensive outburst of scarlatina and throat illness in Russell Square and its neighbourhood. Prompt investigation of the outbreak by the Medical Officer of Health for St. Giles District (Mr. Lovett) showed that well-nigh all the cases of scarlatina and throat illness coming under notice between 14th and 30th January had occurred among the customers of a particular retail milkseller. And further it was ascertained on conference with the health officers of districts adjoining St. Giles, that scarlatina and throat illness had also prevailed at the same time among the comparatively few customers of this milkseller residing in St. Pancras, Marylebone, and other districts. Subsequently house-to-house inquiry in those parts of St. Giles and St. Pancras chiefly invaded showed that households getting, during the period in question, their milk supply from dairies other than that already referred to, almost wholly escaped illness. In a word, there is abundant evidence that milk from the particular dairy was in the latter half of January concerned in a sudden and widespread dissemination of scarlatina and throat illness.

Very early in the outbreak, indeed as soon as his suspicions respecting the milk-causation of the illness were aroused, Mr. Lovett obtained from the particular milkseller a complete list of his customers, and at once subjected to a very rigid medical examination the milkseller's family as well as the persons employed in his milk business. He found that with the exception of a milk carrier named Cook none of these persons had recently suffered from any indisposition of an infectious sort. The man Cook had, it appeared, suffered from sudden sickness and sore throat on

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the evening of 14th January; next day 15th January, one of Cook's children developed a scarlatinal rash, and in a few days two others of his children fell ill with undoubted scarlatina. Cook, who was himself only indisposed for a few hours, continued daily at his work at the dairy until the 23rd January, when he was discharged from his employment. Mr. Lovett, though disposed to consider the man Cook as concerned in some way with infection of the milk at the dairy in London, proceeded, nevertheless, to inspection of, and inquiry at, the farm in Surrey whence the particular milkseller derived daily the 45 barn gallons of milk which constituted the whole of his supply. In carrying out this inquiry Mr. Lovett had the assistance of the Medical Officer of Health and of the District Medical Officer of Farnham, the district in which the farm is situated. This visit of inspection took place on 27th January, and its result was altogether negative. No scarlatina could be heard of as having occurred at the farm, or within several miles of it, for several months, and examination of the farmer's family and of persons employed about the farm and their families failed in getting suggestion that any of these persons had suffered recently from even trifling illness that might have been of scarlatinal nature. Further examination of the cows and other animals at the farm by certain veterinary surgeons of Aldershot resulted in a certificate that the animals were free from trace of illness of any sort.

Thus the matter stood when I was instructed to make inquiry respecting it.

My first concern was necessarily to examine the evidence implicatory of the particular dairy in St. Giles; and having satisfied myself that there was good ground for believing this milk to have been the cause of the outbreak, my next step was to ascertain, if possible, *where* and *how* this milk had acquired infectious property.

Upon examination of the details of the distribution of the particular milk service, it soon appeared that certain (though comparatively few) of the dairyman's customers had their milk delivered to them from the dairy cart which conveyed the total milk supply of this dairy from Charing Cross Railway Station (whither it was consigned by the farmer) to the particular milkseller's place of business in St. Giles. These customers, therefore, were served with milk that had never entered the milk-shop in question and which had not come into any relation with the man Cook who, as has been seen, suffered on 14th January from throat illness. Certain of the households thus supplied suffered from scarlatina or throat illness; and they suffered simultaneously with the man Cook and his family, and simultaneously also with those other persons in St. Giles and St. Pancras who, like Cook, had been served with milk from the St. Giles dairy-shop. This fact tended to show that the particular milk, or at least a portion of it, was infectious before arriving on the premises of the St. Giles's milkseller. And soon this view got abundant confirmation. It was ascertained that other milk from the Surrey farm besides the 45 barn gallons supplied to the St. Giles dairy had also been distributed in London. Twenty barn gallons daily of milk from this farm had been supplied *viâ* the South-western Railway to a particular dairy in Peckham whence it had been, along with milk from other sources, distributed in the Camberwell district. And in Camberwell scarlatina and throat illness among customers of the particular Peckham dairy were found to have occurred coincidently with the outbreak of similar illness in St. Giles and St. Pancras. Of 39 cases of scarlatina coming under the notice of the Camberwell Medical Officer of Health in households invaded between 14th and 30th of January no less than 32 (82 per

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cent.) were persons getting their milk supply from the particular Peckham dairy. Further, there was independent evidence of the milk from the Farnham farm having been infectious on its arrival in London. At the Waterloo Terminus, where was received the consignment of milk from this farm to the Peckham dairy, servants of the railway company are not permitted to purchase milk arriving at the station; but at Charing Cross, where the consignment for the St. Giles dairy was received, purchase of milk by the railway servants is not prohibited. Thus it chanced that certain of the South-eastern Railway servants had habitually purchased milk from the St. Giles dairy carman as soon as it had been delivered to him. A varying quantity of from two to three imperial gallons of the Farnham milk was thus distributed daily at Charing Cross, and of purchasers of this milk 13 persons in six families were attacked by scarlatina or throat illness about the same time that customers of the particular dairies in St. Giles and Peckham were similarly invaded.

Upon the whole, therefore, the conclusion became irresistible that this milk, delivered from the farm at two separate country stations, belonging to different railway companies, for consignment to separate London termini, and distributed in widely separated metropolitan districts where it caused simultaneous outbursts of scarlatina and throat illness, had become infected at the farm, whence it was derived. Accordingly, attention was given to means whereby it might have become infected at this farm.

Inquiry to this end necessarily traversed ground already gone over by Mr. Lovett, and it further took into account a variety of additional circumstances that might be hoped to assist in throwing a light on the subject. Into the various steps of this investigation I will not now enter, but will briefly state its outcome. I satisfied myself that it was practically out of question that the milk at the farm had become infected in any of the commonly-believed ways that require a human subject as the source of infection; and I think it altogether unlikely that commonplace fouling of dairy utensils by polluted water or the like, after such fashion as has heretofore served to account for specific pollution of milk, can have here occurred. In the end I found myself, as on a former occasion, called upon to face the question whether or not actual cow-conditions might have been competent for the results observed; and in considering this question I came to see that a hypothesis of cow-causation would fit the facts that needed explanation as well as, or even better than, any other hypothesis. If only it could be believed that a single cow of this herd of 60–70 cows had been for a limited time capable of affording specifically infected milk, there was nothing in the routine of the farm dairy arrangements inconsistent with the milk of such single cow having been distributed among the churns consigned from the farm to London; and this in such a manner as to infect simultaneously the milk service of each London dairy supplied from the farm, and during a certain limited period a considerable proportion of that service.

At this stage of my thought on the subject, I took the farmer into confidence and got him to consider with me whether *any new condition* could have entered into his business about the second week in January, and if so, what the nature of it could have been. On reference to his books we found that one of his cows due to calve on the 27th December had calved subsequently to but within ten days of that date, and had come into milking for business purposes three or four days after calving. So far as we could judge this calving constituted the sole new element

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introduced into the milk business of the farm for a considerable period before the milk became infective. Certainly, with this exception, no cow came freshly into milk between mid-November and the end of January. Respecting the health of the particular cow the farmer could say nothing, except that he had not heard of her having had any ailment, while the cowman who had charge of this and of ten other cows professed to be unable to remember the date and particulars of her calving; he even failed to recollect the sex of the calf produced by her. Upon examination of this cow on the 11th February I noted that she had here and there lost portions of her coat, and that her buttocks and posterior udder were fouled and stained by excremental matter, and perhaps by vaginal discharge as well. In this respect she presented a rather strong contrast to most of the other cows.

In this instance then as in similar outbreaks of scarlatina, wherein milk has been undoubtedly the means of dissemination, there has been failure in tracing the source and method of infection of the milk; and this in spite of a great deal of careful and prolonged investigation of the circumstances both by myself and others. It is of course possible that the failure is due to mere lack of evidence respecting occurrences that did actually take place after the milk left the cows and that were competent to have infected the milk in commonly accepted ways. But it is not because this is possible that I ought to decline consideration of other possible meanings of the failure, or that I should hesitate to look at some positive indications which arise as soon as there is seen to be probability that the milk was infected when it left the animal. These indications are indeed of some immediate interest and importance, since they would appear capable of being put to the proof by actual experiment.

Few physicians will be disposed to deny a relation between scarlatina and certain forms of febrile puerperal disease in women. The contagion of scarlatina introduced into the lying-in room has often and with reason been held responsible for "puerperal fever." It does not matter for my present purpose that there are other contagia having a similar power of mischief there.

Now, if it be true that there is one sort of relation between scarlatina and accidents of the puerperal state, another sort of relation becomes comparatively easy of belief; while there would seem nothing improbable in the further suggestion that all such relations would be qualified by the passage of a common contagion through the system of another animal.

Thus considered, the outcome of my inquiries at this Surrey farm may be not without significance. If scarlatina in man have other animal source than human source, it may be that one such source is the cow that has recently calved, a cow either not at all ill (except for her parturition), or not so obviously ill as to prevent her milk being used for human consumption. Milk of a recently delivered cow might become infective in more than one way. Either it might, as a secretion of the cow, contain infective matter that was circulating in the system of the cow; or else uterine and other discharges of the cow fouling her udder, might, by a careless milker, be mixed with her milk in the act of milking. For the purpose of testing the question here raised by experiment on animals, other than man, all that is required is, first, a healthy cow that has recently calved, and then a succession of cows suffering under one and another recorded ailment, special to the period after calving. Milk from such cows, on the one hand unsophisticated as it came from the udder, on the other hand mixed with one and another kind of vaginal discharge of the cow, could be used for feeding as well perhaps for throat inoculation of some lower animals, and among these young pigs would seem to be promising subjects.

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In conclusion I would advert briefly to some facts which seem worthy of further consideration in this connexion.

(1.) In epidemic outbreaks, referred to milk as their cause, infectivity of the milk has commonly lasted a short while only. In most instances a week or ten days would comprise nearly the whole period during which the implicated milk can be believed to have done mischief. This circumstance accords with some cow-condition as the cause of the milk infection quite as well as, perhaps better than, with any other suggested cause. For instance and from our present view-point, a recently delivered cow would not be long ill, and certainly her uterine discharge would not be expected to continue many days.

2. Epidemic outbreaks among human communities, that have been traced to milk as their cause, have generally occurred in relation with cow-businesses that have had to do with the production of milk and milk alone. Such businesses do not manufacture butter or cheese, nor do they rear calves. Consequently their cows are apt, after having calved, to come almost at once into business use, even though they may have some trivial (in the opinion of those about the cow) ailment, not obviously affecting the quantity or quality of the milk rendered by the cow.

3. In the case of scarlatina, outbreaks due to milk have commonly been characterised by small mortality as well as by mildness of the disease induced. In many such outbreaks, and notably it was the case in the present instance, a considerable proportion of the sufferers have only had sore throat of little severity; and further, this milk-scarlatina has on this as on other occasions been little prone to spread to other persons. These facts, insignificant mortality of the disease induced, its mildness, its tendency to remain localised in the throat, and its small ability to extend itself to persons in relation with the sick people, may be thought of as not inconsistent with an infective cause, having (as in vaccinia) an animal, but not recently a human, origin.

9th March 1882.

Postscript, April 1883.

I have now to report that in pursuance of instructions, I have been in communication with Dr. Klein upon the subject-matter of the above report; and that Dr. Klein has made the following investigations as to relation between human scarlatina and bovine disease. He conducted two series of experiments; reporting on the first series 1st October 1882, on the second series 27th March 1883. One or two comments of my own are introduced into the story. The results appear to me to indicate that this line of inquiry is well worth pursuing further.

W. H. P.

First Series of Experiments.

Experiments on animals, Series I.

Dr. Klein sought to ascertain (1) whether the *lochial discharges* of a reputedly *healthy* cow could, when inoculated into, or administered along with food to, certain other animals, produce in them any obvious illness. Afterwards (2) he sought to learn whether any form of illness might be producible in a cow by inoculating and feeding the animal with scarlatinal matter derived from a human source. On observing any such illness, he sought to investigate its transmissibility from the cow to other animals.

1. These experiments failed altogether; they were as follows:—

Inoculation and feeding of animals with lochial discharge of a healthy cow.

(*a.*) Pigs, dogs, rabbits, guinea-pigs, mice, and rats, were fed and inoculated with lochial discharge, unaltered as it came direct from a

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"healthy cow"; and similarly animals of the above sorts were fed and inoculated with lochial discharge that had been mixed with and left for a while in milk. None of these animals, however, developed any sort of illness. The animals experimented on were, says Dr. Klein, closely observed, and their temperatures taken twice daily. But in no case was deviation from the normal state of the animal observed.

Cultivation of matter of lochial discharge of healthy cow and subsequent inoculation of animal with cultivate.

(*b.*) Further, Dr. Klein cultivated artificially the lochial discharge from the same cow, and found that "organisms" grew copiously in the cultivation medium; and that the characters of these organisms differed according to the dates at which the lochial matters cultivated were taken from the cow. But inoculation of "animals" with these cultivated organisms failed in producing in the animals any illness.

Inoculation of cow with scarlatinal material.

2. Inoculation shortly afterwards of the same cow with human scarlatinal material produced some definite results.

(*a.*) Desquamated cuticle from a scarlatina patient inoculated into a healthy cow produced no illness; but

(*b.*) Muco-purulent throat discharge from a scarlatina patient inoculated subsequently into the subcutaneous tissue of the same cow (with simultaneous administration to the cow of a small dose of the same material poured down its throat) did produce in the cow distinct illness, as follows:—

Ten or eleven days after this inoculation and feeding there appeared at the inoculated point on the thigh of the cow a firm swelling, and in another day or two a similar swelling on the outer surface of the cow's right lower jaw. Each swelling quickly attained "the size of a small fist." That on the thigh softened, and subsequently, when lanced, discharged a quantity of offensive pus; that on the jaw did not soften, and in about a fortnight had disappeared. The temperature of the cow during the whole period that she was under observation did not show any marked alteration, but the animal grew very thin and miserable notwithstanding that she received abundant and good food.

Inoculation of pus from ? scarlatinally-infected cow into dogs.

(*c.*) *Transmission of the induced cow disease to another animal.*—Dr. Klein inoculated two dogs with pus from the above abscess of the cow. In each instance a minute speck of this pus was introduced into the subcutaneous tissue of the dog's thigh. *About four days* after inoculation one of the dogs developed in and about the seat of inoculation a great deal of redness along with œdematous and painful swelling, and these phenomena were preceded by a distinct rise of the dog's temperature. Movement of this animal's affected limb became greatly impeded, and the dog was for a time distinctly ill; an abscess formed at the seat of inoculation which opened spontaneously, and, after discharging for a time, quickly healed. The throat of the dog did not become affected.

Dr. Klein; conclusions on experiments in Series I.

From these experiments Dr. Klein entertains no doubt whatever as to his having by inoculation with human scarlatinal material, transmitted to a cow a distinct disorder, which disorder was further transmissible, by inoculation in infinitesimal quantity of pus from an abscess in the cow, to a dog. And he points out that the four days incubation period observed in the case of this dog is of especial importance. He lays stress on it for the reason that by no reasonable amount of ordinary pus can similar disorder be produced in dogs; and further he remarks that such disorder as may be produced in dogs by injection into their veins of ordinary pus promptly follows injection without any such interval as deserves the term "incubation period."

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Second Series of Experiments.

These consisted in (A) repetition of the above experiment of transmission by inoculation to animals of human scarlatinal disease; and (B) of experiments (of the sort adopted in Series I.) made with the lochial discharges of an originally unhealthy but recently calved cow that had in addition been, immediately after her calving, inoculated and fed with muco-purulent throat discharges from a scarlatina patient.

Further inoculation of animals—heifers and dogs—with scarlatinal material.

A. (*a.*) On 21st October a healthy heifer (yearling) was inoculated with throat discharge from a case of acute scarlatina.

(*b.*) On 21st October a second healthy yearling heifer was fed with like material.

(*c.*) On 21st October a dog was inoculated with like material.

Up to 6th November (17 days) no change whatever was observed in the health of any of these animals.

(*d.*) Accordingly on this day, 6th November, both heifers were inoculated with large quantities of muco-purulent throat discharge from a case of acute scarlatina, and one of these heifers was in addition fed with such matter. Similarly the dog (*c.*) and another dog were inoculated with the scarlatina matter.

Not one of these animals became in the least degree ill.

[It is noteworthy that this experiment differs from experiment 1, series I., in that the bovine animals here used were not milch cows that had recently calved, but heifer yearlings. And the question promises to arise whether in this class of animal the parturient state is a condition more or less essential to the reception of the human scarlatinal infection. As regards dogs, let it be noted that Dr. Klein's previous success (series I., experiment 2 (*c.*)) in inoculating these animals was not obtained with human scarlatinal matter, but with matter of the induced disease of the cow.]

Unhealthy cow inoculated and fed with scarlatinal material.

B. Another cow was taken for observation that fed fairly, but had lost patches of its coat and was believed to be suffering from some such chronic bovine disease as tuberculosis. She calved on 25th February 1883. On the evening of that day muco-purulent throat discharge was obtained from a scarlatina patient at Fulham Hospital in whom the disease had somewhat passed the most febrile stage. This discharge was on February 26th inoculated into the subcutaneous tissue of the cow, and some of the scarlatina material was poured down its throat.

? Failure to infect cow with scarlatinal disease.

An abscess, the size of a hazel-nut, afterwards formed at the seat of inoculation, and the abscess broke and healed up soon.

[The effect upon the cow of this inoculation with human scarlatina was inconsiderable. But, in so far as it may be permitted to judge from the experiments of October 21st on the two healthy heifers, some condition peculiar to this cow must have been present for any result at all to have followed the inoculation. And this condition may either have been the fact of her parturition or else her previous ill-health. Comparing the present experiment with that made on the healthy cow of the first series, there is enough similarity of result to suggest afresh that the purturient condition was that which contributed to the production of abscess in the present cow.

As regards any conclusions which may be deducible from the results which I have now to record, as obtained by inoculating various animals with the discharges of this cow, the state of health of the cow immediately antecedent to her calving must (Dr. Klein insists) be unfailingly held in view. This particular animal was, just at the time of her calving, the subject of some ailment or other of her own, independent of any disease produced in her by inoculation; and one evidence of this ailment

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was a loss of hair. At first, indeed, this was regarded as a chronic complaint that would not affect the lessons of the experiment; but it presently became manifest to Dr. Klein that this particular cow, affording him affirmative results when her discharges were inoculated into dogs and pigs, might possibly, for all he could affirm to the contrary, have been suffering under some complaint having analogy with scarlatina, though productive of only trifling constitutional effect upon the cow and not interfering with her processes of parturition and milk-formation.]

Inoculation experiments with mixture of lochial discharge and milk of the cow.

In the meantime, on 26th February, Dr. Klein took lochial discharge from this cow and added it to the milk of the animal; and on 28th February he took more lochial discharge and added it to the sample of milk already polluted on the 26th. With this mixture on 28th February he inoculated (in amount one to two divisions of a Pravaz syringe) the subcutaneous tissue of the inguinal regions of—

(1.) Two dogs, *a.* and *b.*

(2.) Two pigs, *a.* and *b.*

And with a few drops only of the mixture—

(3.) Four guinea-pigs.

The temperature of all these animals was taken before experiment, and subsequent to experiment was taken twice daily during several weeks.

As regards the dogs: results were as follows:—In both there was after 24 hours (on 1st March) painful swelling and stiffness of the leg on the sides operated upon, with rise of temperature one degree centigrade.

Experiments on dogs.

(Dog *a.*)—After 48 hours (2nd March) had at the seat of inoculation a large ulcer with reddened and swollen margin, and exuding a discoloured ichor; while the neighbourhood of the ulcer looked erysipelatous. The animal was dull and fed badly. After 96 hours (4th March) this dog's wounds was granulating and healing.

Dog (*b.*) After 48 hours (2nd March) had a swelling the size of a pigeon's egg in the inguinal region, but its temperature was normal and it fed well. After 96 hours (4th March) this dog had distinct swelling and redness of the mucous membrane of the throat, with muco-purulent matter on the tonsil. The temperature was normal.

Experiments on pigs.

As regards the two pigs: After 48 hours (2nd March) both had much inflammation and œdematous swelling at the seat of inoculation. Temperature normal; fed well.

Pig (*a.*) after 3rd March, coughed; on 18th March it was still very poor and dull. Temperature had risen one degree centigrade.

Pig (*b.*) coughed on March 18. Temperature same as pig (*a.*)

Experiments on guinea-pigs.

As regards the four guinea-pigs: After 48 hours (2nd March) there was much swelling at the seat of inoculation, but temperature was normal, and the animals were lively. Subsequently the inguinal swellings increased and became abscesses full of cheesy pus.

Transmission of the induced Disease in the Dog to other Dogs.

Further inoculation experiments in second generation of infective material.

On the 3rd March Dr. Klein took by capillary glass tube fluid from the inguinal swelling of dog (*b.*) (the dog that had on 4th March affection of the throat). This fluid was red and contained numbers of red blood corpuscles and pus corpuscles, and as well what appeared to be micrococci. With one or two drops of the fluid Dr. Klein inoculated freshly-made incisions in the inguinal regions of two other dogs (*c.*) and (*d.*).

On dogs.

Dog (*c.*) On the 8th day (10th March) after inoculation there was distinct rise of temperature, amounting by next day to two degrees

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centigrade; and the throat had become much inflamed. By the 12th day (14th March) the temperature of this dog had again become normal, but its throat remained much inflamed. The animal, however, fed well. On the 13th day (15th March) this dog had two epileptic fits, and it died two days later. *Post-mortem appearances: Lungs*, consolidations in both, especially in the right; *Spleen*, a bulla full of black blood on outer surface; *Liver and kidneys*, congested; *Intestines*, a quantity of matter like old (? altered) blood at pyloric end of stomach, in duodenum and in rectum.

Dog (*d.*) On 17th day (19th March) its temperature had risen half a degree centigrade. On 18th day (20th March) its temperature had risen another half degree, and its throat was discovered to be much inflamed, and there was muco-purulent discharge from the left tonsil.

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No. 10.

On an Extensive Outbreak of Enteric Fever at Bangor and its Neighbourhood; by Dr. F. W. Barry.

* * * * *

Bangor is a well-known cathedral town and small port situated at the entrance of a valley which opens upon the Menai Straits. It consists of a crooked High Street more than a mile in length, which runs along the eastern side of a small stream called the Adda River. Between this street and river there is, commencing from the shore first, an irregular block called Hirael, containing, in numerous streets and cross streets, many of the oldest houses in the town. A few hundred yards from this we come upon the main part of the town, or Bangor proper, which extends on both sides of the High Street, but principally towards the river. This may be said to continue as far as the railway station, after which Bangor West End begins. Still further to the south-west is Glanadda, a suburb of the town situated in the Rural Sanitary District. On the opposite side of the valley to Bangor proper, and extending to the summit of the hill, is the new and well-built suburb of Upper Bangor. On the promontory opposite Hirael is another detached portion of the town, called Garth. A few houses called Port Penrhyn are situated to the east of Hirael, and are in the Rural Sanitary District. To the south-east of Port Penrhyn, and at a distance from it of two miles, lies the small village of Llandegai in the valley of the Ogwen. This is in the Bangor Rural Sanitary District. About four miles beyond this is Bethesda, a Local Board District, having a population of nearly 7,000. The population of the Bangor Urban Sanitary District was, in 1881, 8,240.

* * * * *

Water Supply.—The water for domestic purposes is obtained from the Afon Gaseg at a point below its junction with the Afon Llaver. It passes by means of a 9-inch pipe into a filter bed (which consists of about 10 inches of sand and 4 of gravel), and thence into a small reservoir. From this the water is conveyed by a 9-inch main through Bethesda and along the road through Llandegai as far as the main entrance to Penrhyn Castle, where it divides into two 7-inch pipes, one of which carries the supply to Penrhyn Castle, Hirael, High Street, Garth, West End, and Glanadda, the residue going into the Nant reservoir. The other pipe after supplying Port Penrhyn discharges into Twr Gwyn reservoir, which in its turn supplies Upper Bangor. In the course of the main from its source to Penrhyn Castle gate, branches are given off at various points to supply houses at Bethesda and Llandegai and certain detached farm houses on the road side. The supply is constant, and as the upper reservoir is about 500 feet above the town, at high pressure. Cisterns are not in use except for supplying water-closets. In Llandegai and in the poorer parts of Bangor the supply is obtained from stand pipes. At certain irregular intervals the 9 and 7-inch mains are flushed from the reservoirs at Bethesda into the River Cegin, at a point about 500 yards above the Penrhyn Arms Hotel on the Llandegai road, by opening sluice valves on the two 7-inch mains.

Upon an examination of the ground in the neighbourhood of the intake above Bethesda, a number of sources of pollution were found; as, for example, at a point about 200 yards above the intake, where the drainage from a privy and two or three pigsties runs into the stream, as does also that of about six or seven houses at Gwernydd. A little farther up the stream the drainage from a cow-house also finds its way in. At a distance of some 350 yards from the intake a small rapid

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stream discharges the drainage of two houses called Llwynrhandir. Several other houses are situated higher up the stream and no doubt drain into it. The reservoirs of Twr Gwyn and Nant have been recently cleansed and whitewashed. They are both uncovered, and that at Nant is from its position very liable to pollution by means of decaying leaves, branches of trees, &c.

In Bangor and Glanadda 1,828 houses are supplied from the Bangor waterworks; in Bethesda, 141; in Llandegai, 31; and 24 detached houses between the two last-named villages also obtain their supply from the same source. In Bangor proper about 10 houses are supplied from other sources, in Bethesda 1,300, in Llandegai, 8, and in Caellwyngrydd 350, besides 32 detached farm-houses between Bethesda and Bangor.

Sewerage and Drainage.—The town of Bangor is drained throughout by means of pipe sewers. The main sewer follows pretty closely the course of the Adda from Glanadda to the outfall, which is at a point a very little below high-water mark to the eastward of Garth. As the tide recedes for a considerable distance there is, in consequence of the situation of the outfall, a large expanse of most offensive matter exposed every low tide all along the shore between Garth and Hirael. Numerous branches are given off from this sewer to Hirael, Bangor proper, Garth, Upper Bangor, and very recently Glanadda has been to a certain extent included within the system. Flushing points exist at the terminal ends of several of the sewers, and I was informed that flushing is carried out in ordinary times at fortnightly intervals. The ventilation of the sewers is extremely defective, the only attempt which has been made to effect this being the construction of some thirty shafts, at the highest points of the sewers, which act to a certain extent as safety valves, and out of which sewer air is given off in a highly concentrated state. Surface ventilation practically does not exist except at the recent extension at Glanadda, where open grids have been provided at the manholes. Here, however, the openings were found, with one exception, to be choked with dirt, which had been in some cases probably dropped by accident from cart-wheels, &c., and in others had been placed there purposely, "to keep in the smell." From the only grid which I found open at the time of inspection the sewer air was emerging in a highly concentrated state, and was undoubtedly a source of great nuisance to the neighbouring houses. The means for inspecting the sewers in the older parts of the town are very defective, neither lamp holes or manholes being placed at the points of change of direction in the sewers. Nearly the whole of the houses in Hirael, Bangor proper, Garth, and Upper Bangor are connected with the sewers, and at Glanadda a certain number have also been connected, but the bulk of the Glanadda houses drain into the Adda. This, which prior to its entering the village is a clean stream, rapidly becomes very foul, as, in addition to sewage, it acts as a receptacle for all kinds of solid filth wherever houses abut upon it, notably in the neighbourhood of Kyffin Square and Glanrafon. At the latter place a slaughter-house is said to drain into it. The Adda eventually discharges into the main sewer at a short distance from the outlet. This so-called river is unquestionably a source of great nuisance to all the houses in its immediate neighbourhood.

The house drainage is very defective. With the exception of one or two houses that have been erected within the last few months, the house drains are connected directly with the sewers, a trap between the two being regarded as an useless superfluity. In a few instances the slop-stone pipes have been cut off outside the houses and made to discharge over trapped gullies, but in the great bulk of the houses the slopstone

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pipes communicate directly with the house drains and are furnished only with either the S or a common bell trap, these again being frequently out of order. In some houses which I inspected in the course of this inquiry I found a strong current of sewer air passing directly through the slopstone pipe into the kitchen and living rooms. In no case did I meet with any efficient ventilation of the soil pipes; in a few instances a 2-inch pipe was continued to the roof as a kind of safety valve, but ventilation by means of two openings in the course of the house drain is unknown in Bangor. Bath waste pipes and overflows were also found, as a rule, to discharge into the soil pipes.

The rain-water fall pipes, as a rule, discharge directly into the drains, and probably, in fair weather at least, some act to a slight extent as ventilators. In many cases the water-closet is situated in the centre of the house, without any windows or means of ventilation except into the adjoining bed and living rooms. One or two of the houses inspected I found to be furnished with one closet in the centre of the house and another outside. The inmates stated that they rarely used the one inside on account of the smell, thus increasing the likelihood of admitting sewer air by the want of water in the traps. The cottages and small houses are far less liable to danger from sewer gas than those of greater pretensions, as in the former the slop sink is almost invariably situated outside and the water-closet detached from the house. In several instances the house drains were found to be choked with sewage.

* * * * * * *

Epidemic of Enteric Fever.—The earliest cases of enteric fever of which I could obtain any particulars as having occurred in Bangor or the neighbourhood since the commencement of the present year (1882), were the following:—On the 4th of March a man died of enteric fever in the infirmary four days after the admission from Penmaenmawr. On the 8th of March a case is reported to have occurred at Caelleppa. On the 27th of March a death was registered from enteric fever at Llandegai in the Bangor Rural Sanitary District. On the 18th of April a death which occurred in the High Street was registered as from "simple continued fever," and from the history of this case I should regard it as doubtful whether it can be included in the category of specific fever. On the 19th of April a case was reported to have occurred on board the training ship "Clio," which was anchored in the Menai Straits. Mr. Rees, the Medical Officer of Health, also informed me that isolated cases of enteric fever had occurred from time to time for some years past in the Bethesda district. The cases noted above show that enteric fever had existed in a sporadic form in Bangor and the neighbourhood for some time previous to the general outbreak. I was, however, unable to trace any connexion between them and the epidemic which has now to be described.

In the subjoined table will be found a complete list of cases, with their localities and the dates of attack, so far as could be ascertained. On examining this it will be found that the outbreak can be roughly divided into three periods; the first from the last week in May to the end of the first week in July. This was characterised by a continued series of dropping cases which during the latter part of the period occurred daily in various parts of the town and district simultaneously. The second period extended throughout the second and third weeks of July, and was characterised by the occurrence of a sudden outbreak which affected the town and neighbouring villages at one and the same time. This was succeeded by a third period, which, like the first, has been characterised by the occurrence of dropping cases from day to day, and which has lasted up to the time of the present inquiry.

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TABLE OF CASES.

126 Households invaded. Total cases, 141.

Week ending.	Locality.	Date of Attack.	Cases in houses not previously affected.	Cases in houses previously affected.
May 23 (2 cases)	Brick Street	May 17	1	—
	Llwynrhandir*	„ 22	1	—
May 30		Nil.		
June 6 (3 cases)	Glendwr Terrace, Garth	June 2	1	—
	Garth Road	„ 2	1	—
	Garth Road	„ 3	1	—
June 13		Nil.		
June 20 (9 cases)	Caelleppa	June 15	1	—
	High Street	„ 15	1	—
	„ „	„ 16	1	—
	Garth*	„ 16	1	—
	Port Penrhyn*	„ 16	1	—
	High Street	„ 18	1	—
	Fron Square, Upper Bangor	„ 20	1	—
	Hirael	„ 20	1	—
	Mount Street	„ 20	1	—
June 27 (25cases)	High Street	„ 21	1	—
	Upper Bangor	„ 23	1	—
	„ „	„ „	1	—
	High Street	„ „	1	—
	„ „	„ „	1	—
	James Street	„ „	1	—
	„ „	„ „	1	—
	Pendre	„ „	1	—
	Fountain Street, Hirael	„ „	1	—
	Hirael	„ „	1	—
	Drum Street	„ „	1	—
	Glanadda*	„ „	1	—
	High Street	„ „	1	—
	Tanyralt	„ 24	1	—
	Pendre	„ „	1	—
	Upper Bangor	„ 26	1	—
	„ „	„ „	1	—
	Friars School	„ „	1	—
	High Street	„ „	2	—
	„ „	„ „	1	—
	„ „	„ „	1	—
	Rathbone Street	„ „	1	—
	Llwynrhandir*	„ 26 ?	2	—
July 4 (25cases)	Glanrafon	„ 28	1	—
	Water Street, Hirael	„ 29	1	—
	Rathbone Street	„ 29	1	—
	Caelleppa	„ 30	1	—
	High Street	„ „	1	—
	Upper Bangor	„ „	1	—
	Friars School	„ „	—	2
	Plas Llywd Street	July 1	1	—
	Glendwr Terrace, Garth	„ „	1	—
	Penralt	„ „	1	—
	Brick Street	„ „	1	—
	Drum Street	„ „	1	—
	Tabernacle Street	„ „	1	—
	„ „	„ „	1	—
	Caelleppa	„ „	1	—
	„	„ „	1	—

* The houses in which these cases occurred were unconnected with the Bangor sewerage system.

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Week ending.	Locality.	Date of Attack.	Cases in houses not previously affected.	Cases in houses previously affected.
July 11 (19cases)	Strand Street, Hirael	July 1	1	—
	Upper Bangor	" "	1	—
	" "	" "	1	—
	Fron Square, Upper Bangor	" 2	—	1
	Ambrose Street, Hirael	" "	1	—
	Well Street	" "	1	—
	Llandegai*	" 3	1	—
	Plas Llywd Street	" 4	1	—
	Lime Grove Lodge	" 5	2	—
	Mount Street	" "	1	—
	Hirael	" "	1	—
	Llandegai*	" "	1	—
	Garth Road	" 6	1	—
	" "	" "	1	—
	Caelleppa	" "	1	—
	"	" "	1	—
	Llandegai*	" "	1	—
	Garden Square	" 7	1	—
	Bethesda*	" "	1	—
	Upper Bangor	" 10	—	1
	Port Penrhyn*	" "	1	—
	Welfield House	" "	1	—
	High Street	" "	1	—
	" "	" "	—	3
	Ciltwllan*	" 12	—	1
	Ambrose Street, Hirael	" "	—	1
	Pendre	" "	1	—
	Llandegai*	" "	1	—
	Penlan*	" "	1	—
	Llandegai*	" 13	1	—
	" *	" "	1	—
	Bethesda*	" 14	1	—
	" *	" "	1	—
	Rathbone Street	" 15	—	1
	High Street	" "	1	—
	" "	" "	1	—
	" "	" "	1	—
	West End	" "	1	—
	Mount View, Garth	" "	1	—
	Plas Llywd Terrace	" "	1	—
	Tabernacle Street	" "	1	—
	Upper Bangor	" "	1	—
	" "	" "	1	—
	Wells Street	" "	1	—
July 18 (40cases)	James Street	" "	—	1
	Summer Hill Terrace	" "	1	—
	High Street	" "	1	—
	Llandegai*	" "	1	—
	Bethesda*	" "	1	—
	" *	" "	1	—
	" *	" "	1	—
	" *	" "	1	—
	Llwynrhandir*	" "	1	—
	" *	" "	1	—

* The houses in which these cases occurred were unconnected with the Bangor sewerage system.

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Week ending.	Locality.	Date of Attack.	Cases in houses not previously affected.	Cases in houses previously affected.
	Friars Road - - - -	July 16	1	—
	" " - - - -	" "	1	—
	Dean Court - - - -	" "	1	—
	" Street - - - -	" "	1	—
	Garth - - - - -	" "	1	—
	High Street - - - -	" 17	1	—
	Bethesda* - - - - -	" "	1	—
	Fountain Street, Hirael - - -	" "	1	—
	Bethel Street - - - -	" "	1	—
	Penrhyn Castle* - - - -	" "	1	—
	Bethesda* - - - - -	" 19	1	—
	James Street - - - -	" 20	1	—
	Union Street - - - -	" "	1	—
	Upper Bangor - - - -	" "	1	—
	Glanadda* - - - - -	" "	1	—
	Pendre - - - - -	" "	1	—
	High Street - - - -	" "	1	—
	Bethesda* - - - - -	" "	1	—
July 25	James Street - - - -	" 21	—	1
(18cases)	Garth Hill - - - - -	" 22	1	—
	High Street - - - -	" "	1	—
	Mountain Square - - - -	" 23	1	—
	Tyddyn Jolyn* - - - -	" "	1	—
	Lime Grove* - - - - -	" 24	1	—
	Hirael - - - - -	" "	1	—
	Penybrotch - - - - -	" "	1	—
	Upper Bangor - - - -	" "	1	—
	Caelleppa - - - - -	" 25	1	—

* The houses in which these cases occurred were unconnected with the Bangor sewerage system.

The first cases which appear to have a direct connexion with the outbreak, in regard to which this inquiry was instituted, occurred in the week ending May 23rd, one in Brick Street, Bangor, on May 17th, and one on May 22nd in Llwynrhandir, a house situated near the River Gaseg, above the intake of the Bangor Waterworks. In the week ending May 30th no fresh cases occurred, but in the first week in June three persons were attacked in Garth. In the next week there were again no cases, but from the 15th June to the 7th July fresh cases were reported almost daily, until by that date no less than 76 cases had occurred in 70 households.

From examination of the list of cases in detail it will be seen that on several occasions there was a simultaneous appearance of the disease in various districts and streets. This at once suggested some common medium of infection, and a careful examination was first made of all the sources of milk supply, with, however, negative results, as in addition to the fact that patients were found amongst the customers of almost every milk dealer in the town, many of them kept their own cows, and obtained their milk from no other source.

The evidence with regard to infection by means of sewer air was also negative, at any rate in the earlier cases. Let us take for instance those which occurred during the week ending June 20th. Here we find one case in Caelleppa, three in different parts of the High Street, one in

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Mount Street, one in Upper Bangor, one in Hirael, one in Port Penrhyn, and one in Garth. The houses in which the two last occurred were not connected in any way with the sewerage system. Curiously enough also each of the other cases was on a different branch sewer from all the rest, and none had any connexion (except through the main sewer) with the branches which may be assumed to have been infected by the case in Brick Street which commenced on the 17th May, and the three cases in Garth, which occurred during the first week in June. In the succeeding week ending June 27th, a still wider extension took place, including many parts not previously affected, the disease appearing in all parts of Upper Bangor, Hirael, and Bangor proper. In addition to these there was a case at Glanadda in a house which had no connexion with the Bangor sewerage system. Two additional cases also appeared at Llwynrhandir, brought on no doubt by direct infection from the case which began here on May 22nd. These cases were of an extremely mild type, and the exact date of their commencement is very doubtful. From the 27th June to the 7th July there was daily a steady increase in the number of cases occurring within the area of the water service. There were two cases at Lime Grove on the 5th, two in the village of Llandegai, two miles from Bangor, on the 3rd and 6th respectively, and one at Bethesda, some six miles off, on the 7th. None of these last cases were in houses connected with the Bangor sewer system, or had any common source of milk supply, but all the cases with the exception of those at Llwynrhandir which had occurred up to this date had had one and the same source of water supply, viz., that from the Bangor Waterworks.

Thus, up to July 7th, the disease had appeared in all parts of Bangor, and in the three villages of Bethesda, Llandegai, and Port Penrhyn, which were totally unconnected with the Bangor drainage system, or with one another, and in Glanadda, which was only connected in a minor degree. The question now comes to be considered whether any source of specific pollution to the general water supply was in existence prior to the general outbreak in June and July. I have already directed attention to the case of enteric fever which occurred towards the end of May at Llwynrhandir, and shall now proceed to consider the circumstances in detail. On the 13th June Mr. Rees, the Medical Officer of Health, having been informed that a suspicious case had occurred in this house, visited it; the inmates, however, denied that there was any fever there at all, and stated that the patient was suffering from bronchitis. Mr. Rees was satisfied that his suspicions were correct, and in this opinion he has been fully justified by the medical gentleman who attended the case, who informed me that it was an extremely well marked case of enteric fever of a severe type. Mr. Rees directed the inmates to bury all excreta, &c., and this they at the time promised to do. From information, however, obtained from credible witnesses, I am convinced that nothing of the kind was done until a considerably later period, when no doubt the discharges from this particular patient were buried in the garden. The slops and washing water from this house are thrown into a sink at the back and pass by means of a covered rubble drain along the back of it and the house adjoining, where it discharges into a small rapid stream, which in its turn is conveyed as far as the boundary wall of the garden in a similar covered drain, and is thence conducted by means of an open ditch direct to the River Gaseg, into which it discharges at a point about 350 yards above the intake of the Bangor water supply, the whole distance from the house to the intake being about 700 yards. Upon removing some of the stone covers from a portion of the stream near the house a most offensive smell was perceived. The stream has an exceedingly rapid flow, so much so indeed that some whitewash which I poured into the sink behind the infected house could

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be traced for a considerable distance towards the Gaseg. It will thus be seen that there is a direct communication between the infected drain at Llwynrhandir and the small stream from which the Bangor water supply is drawn, and in this manner no doubt infected matter found its way into the filtering reservoir. The privy at Llwynrhandir is of the ordinary cesspit type; the pit is, however, below the level of the drain already referred to.

As to the capability of the filtering material in the filtering beds at the waterworks for destroying or preventing the passage of infective matter we know little, and here the question need not be considered, because I found that from the presence of old defective plugs in the filters themselves, fully a third of the water was passing direct into the watermain without any filtration whatever. The filtering sand has not been renewed for a great number of years, although I understand that it undergoes a certain amount of cleansing from time to time. I was further informed by the clerk to the Urban Sanitary Authority, who is also the waterworks manager, that from the peaty character of the water, the filters frequently become clogged, and at such time the water cannot be filtered rapidly enough to meet the demand, hence the water is passed into the mains without any attempt whatever at filtration.

Here, then, we have established a direct means of communication between the consumers of water and the specifically poisoned contents of a drain at Llwynrhandir; further, we have cases occurring simultaneously miles apart from one another, which, with the exception of the water supply, had no circumstances in common, there being also an entire absence of cases in houses not so supplied. I have therefore now no hesitation in attributing the primary spread of the disease to the water supply.

Before leaving the subject of this primary outbreak it will be noticed, on an examination of the table, that a sudden increase in the number of families invaded occurred on the 23rd June and 1st July, and it is interesting to observe from the rainfall register herewith appended that about ten days or a fortnight prior to each of these occasions there had been a considerable fall of rain (which was probably much heavier at Bethesda, from its superior elevation, than at the station), thus affording increased facilities for the washing out of the infected drain, and for the conveyance of specific matter to the water supply.

Register of Rainfall taken at Bryn-y-Menai, Bangor, during May, June, and July 1882. *Inches.*

Day of Month.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	·42	·06	—	—	—	—	—	—	—	—	—	—	—	—	—	—
June	—	—	·11	·05	—	—	—	·56		·10	·03	·09	1·00		—	—
July	—	—	—	·20	·06	·03	·56	—	·03	—	·03	·09	·12	—	·56	—

Day of Month.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
May	—	—	—	—	—	·41		·85	—	·09	·11	·12	—	—	—	2·06
June	·75			—	·53	·25	—	·23	—	·05	—	—	—	—	—	4·15
July	·08	·21	·02	—	·30	·16	·45	·06	—	—	·16	·01	·36	—	·07	5·36

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We have now to consider the second period of the epidemic. From the 10th to 17th July, inclusive, a remarkable extension of the disease occurred, during which no less than 39 new households were affected (20 of them, it is said. in one day, July 15th) in widely different localities.

Two cases occurred in Llwynrhandir and its neighbourhood, 7 in Bethesda, 1 at Penlan (a detached farmhouse on the road between Bethesda and Bangor), 4 in Llandegai, 1 at Penrhyn Castle, 1 in Port Penrhyn, 2 in Hirael, 15 in Bangor proper, 1 in Bangor (west end), 3 in Upper Bangor, and 2 in Garth. Besides these, 8 new cases occurred in houses previously affected. The two at Llwynrhandir probably contracted the disease by direct infection from the original cases, one of them having been exposed to it by acting as nurse, and the other living in the next house. Of the seven reported from Bethesda, two were imported from Bangor, and three others were supplied with water from the Bangor main. The remaining two were stated to receive a separate supply from a spring near their houses, but upon further inquiry I ascertained that about the end of June and beginning of July this source had failed, and they obtained water for drinking purposes from friends who took the Bangor supply.

At Penlan the water was also received from the Bangor main, and the four additional cases from Llandegai had it from the same source. One of these cases was that of a young man who is engaged at work at a distance from the district during the week, only returning to Llandegai on Saturdays and Sundays. He was first affected on July 13th, and had been at home on the evening of the 1st and all day on the 2nd, when he was known to have drunk plentifully of the Bangor water. On the 17th a case occurred at Penrhyn Castle, which possesses a separate supply pipe from the mains, as already stated, and which has no other circumstances than its water supply in common with the previously infected districts. Of the numerous other cases which occurred in all parts of Bangor at the same time, some, undoubtedly, received the infection from previous cases there by means of the sewers, still many of these could not be thus accounted for, and the occurrence of such a number of cases simultaneously over such a wide-spread area pointed to some further cause than that already referred to with regard to the first outbreak.

I now proceed to point to what I consider as the solution of the matter.

On the evening of June 29th the mains between Bethesda and the River Cegin were flushed in the manner already described (*see* page 72). The sluice valves were closed at about 1 o'clock on the morning of the 30th. This was done suddenly, and in consequence the 9-inch main burst at a point between Penlan and the main entrance of Penrhyn Castle, about 240 yards from the former and 590 from the latter. The water ran to waste at this point until 2 p.m. on the 30th, when the valve at Bethesda was closed and the pipe repaired. In the evening the water was again turned on, the town, with the exception of Upper Bangor, having in the meantime been without water, or with a very short supply, for nearly 24 hours.

Now we already know that under certain conditions no attempt whatever is made at filtration of the water, and in consequence of the great waste, owing to the burst on June 30th, it may be safely assumed that on July 1st the plugs were withdrawn and the water passed directly into the mains from over the filter beds. In this case, as the orifice of exit is only 3 inches above the surface of the filtering material, there can be no doubt that any dirt which had accumulated on the top of the filter

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would be carried into the reservoir and thence into the mains. But even assuming that the plugs were not removed there can be no question that a great disturbance did take place in the reservoir and filter beds on July 1st and 2nd, as from all sides I received information that on those days the water was much discoloured, and even in some cases it was stated to have smelt offensively.

The facts, then, are these:

(*a.*) That the original case at Llwynrhandir, which began on the 22nd May, had probably been passing infected matter into the River Gaseg to a greater or less extent from that date until June 30th.

(*b.*) That, prior to June 26th, two further cases had occurred in the same house, and that in these, owing to the mildness of the disease, no precautions had been taken, and the danger of the infected matter passing into the stream had been thereby much increased.

(*c.*) That owing to the flushing and consequent bursting in the water main, considerable disturbance occurred in the water supply on June 30th and July 1st.

(*d.*) Finally, that a simultaneous outbreak in various new localities occurred from ten days to a fortnight after this took place.

From the 17th July to the 25th 18 new cases have been reported, occurring in 17 new households. The greater number of these houses are on the line of previously infected sewers. In several which I personally examined, in which servants were the sufferers, I found that sewer air was laid directly on to the slopstone at which they worked.

From the commencement of the epidemic to the end of July the total number of cases reported to have occurred was 141, 83 males and 58 females. Nine were persons under 10 years of age, 87 between 10 and 25, 36 between 25 and 50, and 9 over 50. Of the total cases, 8 had up to July 31st proved fatal. I had an opportunity of examining several of the patients, and found that they presented typical symptoms of enteric fever, the rash, temperature, and diarrhœa being in most cases well marked. In several instances hæmorrhage from the bowels had occurred.

Taking all the facts of the case into consideration, it is my opinion that the water supply became specifically infected to a slight degree on or about May 22nd, and that this pollution continued until the end of June. That this continuous slight pollution accounts for the dropping nature of the cases up to July 7th. That the special outbreak in the second and third weeks of that month was due to the communication of infected matter in a concentrated form owing to the disturbance in the reservoir and filter beds, resulting from the accident to the main on June 30th. Finally, that a certain number of the cases which have occurred from the end of the first period to the present time are due to the direct introduction of infected air from the sewers into which the discharges from cases of enteric fever had been received.

* * * * * * * *

The history of this inquiry shows that the spread of fever in Bangor was almost if not entirely owing to causes directly under the control of the Sanitary Authority, viz., the liability of the water supply to contamination, the defective ventilation of the sewers and house drains, and the foul accumulations of excrement and refuse in the town. These latter, even where not actually the initial cause of the disease, undoubtedly favoured its spread.

12th August 1882.

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App. A. No. 10.

On Enteric Fever at Bangor, &c.; by Dr. Barry.

Postscript (Sept. 20, 1882).

In consequence of the continued prevalence of enteric fever in Bangor, I paid a second visit to the city and neighbourhood on the 12th September to ascertain the extent of the epidemic and the measures taken by the Sanitary Authorities concerned to check the spread of the disease.

The total number of cases reported to the Authorities from the 1st August to the 12th September will be found in the annexed table. This only represents approximately the number of cases, as some of the medical practitioners in the district have not furnished complete lists of their patients to the Sanitary Authorities.

Bangor Urban Sanitary District		306
Bangor Rural Sanitary District.	Glanadda	7
	Llandegai and neighbourhood	17
	Other parts of R.S.D.	6
Bethesda Urban Sanitary District		46
Cases which received infection in Bangor, but removed to other districts		20
Training ship "Clio"		2
Cases on board other ships in harbour		3
Total number of cases reported between 1st August and 12th September		407
Cases reported prior to 1st August		141
Total number of cases of Enteric Fever from commencement of epidemic to the 12th September		548

Of these 548 cases, 29 in the Bangor Urban, 3 in the Bangor Rural, and 10 in the Bethesda Urban Sanitary Districts respectively, had proved fatal up to the 12th September.

At the time of my visit the Bangor Urban Sanitary Authority appeared to be acting most energetically in the directions indicated by me on my interview with the Authority on the 3rd August.

All sources of pollution to the water supply on the East bank of the River Gaseg had been cut off by means of an intercepting trench which discharges below the intake.

The old filtering material had been removed and the water was being sent through the mains unfiltered.

A house-to-house inspection of the city was in progress in order that defects in the drainage and water supply, &c., might be at once remedied.

Up to the time of my visit, 49 houses had been thoroughly disconnected from the sewers, 12 cesspit privies abolished, and between 70 and 80 nuisances abated. The sewers were being flushed daily and periodically disinfected.

Ventilators were in progress of construction at intervals of about 100 yards in all the main sewers.

A house named Fairview had been taken and fitted up by the Sanitary Authority as a temporary hospital; this secured the isolation of 24 patients. Tent hospitals giving accommodation to 20 patients had also been erected, and in addition to these temporary hospitals, 11 patients were accommodated in the Infirmary, and 7 in the infectious ward at the Union Workhouse.

It is, however, much to be regretted that considerable delay took place in the carrying out of some of the more important of the above

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measures, *e.g.*, the removal of the old filtering material was not ordered by the Sanitary Authority until August 17th, and the work was not executed until the 5th of September. The provision of efficient ventilation for the main sewers, to the necessity for which I had drawn particular attention on the 3rd August, was only ordered by the Sanitary Authority to be done to a limited extent on the 31st August, and not fully until the 7th September, the work being in progress at the time of my second visit.

The Bethesda Urban Sanitary Authority, who labour under the disadvantage of not having any system of drainage in their district (the construction of a complete system of drainage is in progress), were found to be acting most energetically in the removal of nuisances, and the disinfection of all refuse matter and drains in the neighbourhood of infected houses. This Authority had further fitted up a large schoolroom as temporary hospital for the accommodation of about 30 patients.

Note by the Medical Officer.—After the above date, and (it would seem) as the result of the energetic action of the Urban Sanitary Authority, the epidemic of enteric fever at Bangor very rapidly declined.

G. B.

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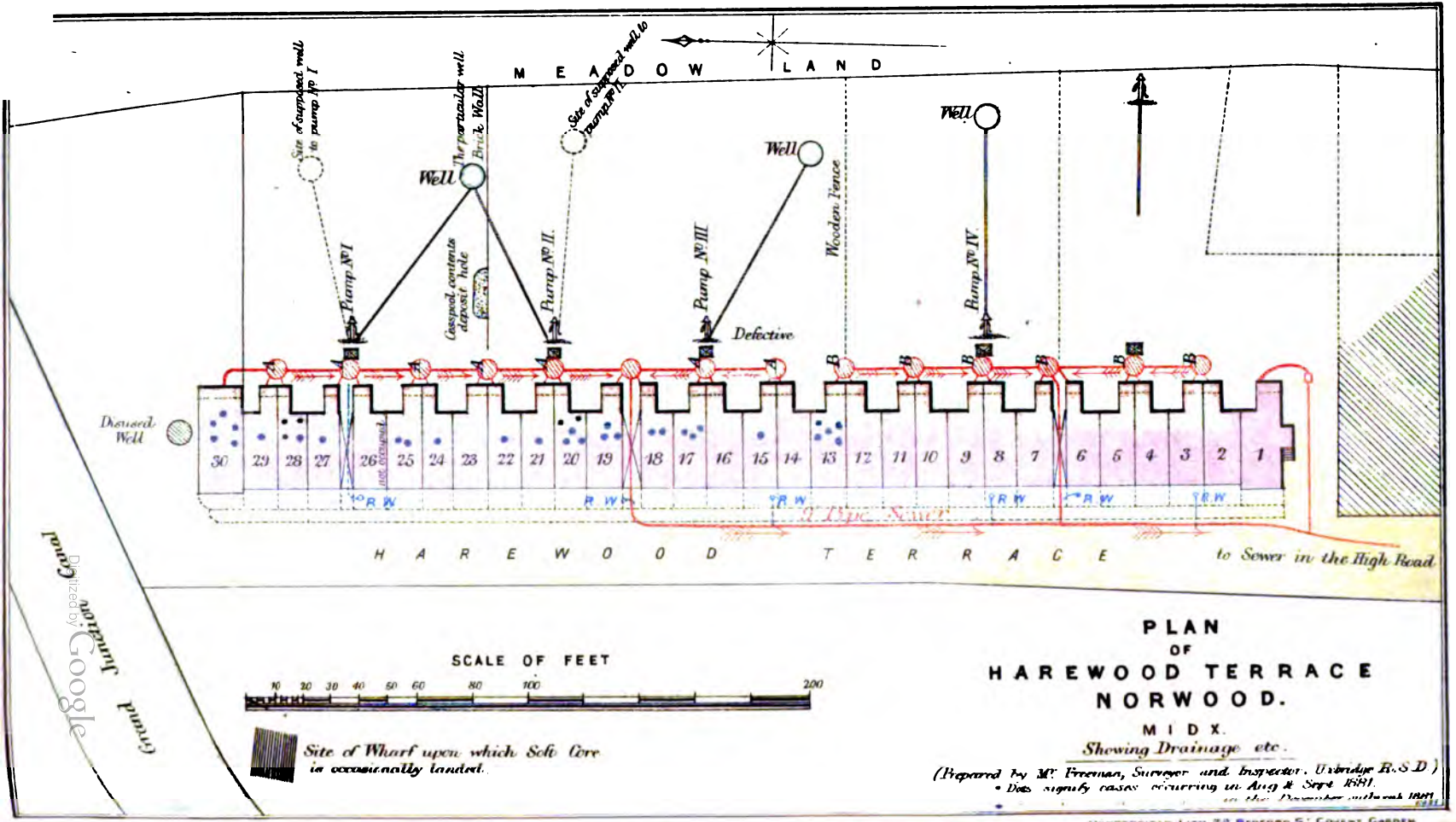
MEADOW LAND
Site of supposed well to pump No I.
The particular well
Brick Wall
Site of supposed well to pump No II.
Well
Well
Well
Wooden Fence
Pump No I.
Cesspool contents deposit hole
Pump No II.
Pump No III.
Pump No IV.
Defective
Disused Well
30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
R W
Q Dic Sewer
HAREWOOD TERRACE
to Sewer in the High Road
Grand Junction Canal
SCALE OF FEET
10 20 30 40 50 60 80 100 200
Site of Wharf upon which Soil Cove is occasionally landed.

PLAN OF HAREWOOD TERRACE NORWOOD.

MIDX.

Showing Drainage etc.

(Prepared by Mr. Freeman, Surveyor and Inspector, Uxbridge R.S.D.)

* Does signify cases occurring in Aug & Sept 1881.

Lithographed Lith 22 Bedford St Covent Garden

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rain spouts at the front of the houses are trapped before entering the drain in the private road. Rain spouts at the back of the terrace are directed into water tubs or discharge over the surface. *Ashes and refuse* as well as cesspool contents (when cesspools are emptied) are utilized over or buried in the gardens.

The outbreak.—The outbreak of enteric fever in this terrace in December comprised some 30 cases in 14 houses. Until this occurrence there had not been for several years in Norwood any outbreak of like suddenness and magnitude, though the district may be regarded as seldom for any length of time altogether free from fever: only last autumn there occurred a small and circumscribed outbreak of this fever at Norwood Green, a quarter of a mile distant from Harewood Terrace, and about the same time a few cases occurred in this terrace also. Locally various notions were entertained as to the cause of the December outbreak, and special stress was laid on the fact that the landing at the wharf adjoining Harewood Terrace of "soft core" manure brought from London, had of late become an increasing frequent occurrence. Soft core consists, it would seem, of dustbin contents with garbage of various sorts, and unquestionably the effluvium of soft core is commonly very offensive and very nauseating. Deposit therefore of several barge loads of this stuff on the wharf referred to about the time of the occurrence of the outbreak sufficed to satisfy not a few persons that soft core must have caused the fever. The medical officer of health of the Uxbridge rural sanitary district, Mr. Roberts, showed however that whatever may be the ability of soft core to occasionally cause fever, it could hardly in the present instance be with justice accused of having done mischief, for at the time in question all the houses in Harewood Terrace had been exposed to, and most of their inhabitants had been annoyed by, soft core effluvium, whereas the fever cases had been strictly limited to the upper part of the terrace. He therefore was disposed to refer the fever to impurity of water supply, and to defects of drainage, circumstances that might have been peculiar to a part only of the terrace. At this stage I was instructed to confer with the medical officer of health on the subject of the outbreak; and I set to work with his and the inspector of nuisances (Mr. Freeman's) assistance to study exactly the circumstances of the terrace and its inhabitants, with a view of determining which of the above, or what other likely cause of enteric fever was chiefly responsible for the outbreak. For it was only by minute differentiation of the circumstances of the houses and persons attacked and those not attacked by the fever, that trustworthy indications as to the precise cause of the outbreak were to be hoped for. Investigation therefore was concerned with the smaller details of the special localisation of the fever already referred to; and at the same time it took into account the time-incidence of the disease on the part of the terrace invaded, the sources of various articles of food that might have conveyed infection to the persons attacked, the circumstances of the life of those persons and their house-mates, and certain physical conditions appertaining to their dwellings. In what follows, the reader will find convenience in consulting the accompanying plan.

1. *Localisation of the Fever.*—Detailed inquiry on this point showed that since August 1881, 12 occupied houses (Nos. 1 to 12, inclusive) in the lower part of the terrace had wholly escaped fever. In the same period and in the upper part of the terrace 15 families in 17 occupied houses (Nos. 13 to 30, inclusive) had been invaded. Among the 15 families there had been 35 cases, none of which (though several patients

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relapsed or had severe bowel hæmorrhage) had so far proved fatal.* The incidence of the fever on the population of the terrace at several ages is given in the following table :—

TABLE I.

Lower part of Harewood Terrace, Houses numbered 1 to 12 inclusive.			Upper part of Harewood Terrace, Houses numbered 13 to 30 inclusive.			
Ages.	Number of Persons living.	Number of Persons attacked.	Ages.	Number of Persons living.	Number of Persons attacked.	*Attacked per Cent. of Total.*
0— 5 years -	8	—	0— 5 years -	20	5	25·0
5—15 „ -	15	—	5—15 „ -	29	20	69·0
15—25 „ -	5	—	15—25 „ -	10	2	20·0
25—40 „ -	7	—	25—40 „ -	27	7	25·9
40 + „ -	16	—	40 + „ -	11	1	9·0
All ages -	51	—	All ages -	97	35	36·0

This table is instructive in more than one way. It demonstrates very clearly the limitation that has been noted of the operation of the cause of the fever to a particular part of Harewood Terrace. Also it shows in the very intensity of the incidence of the disease thereon, and especially in the varying intensity of its incidence with reference to the age, and therefore the susceptibility, of the inhabitants, a cause of fever operating pretty uniformly on the population whatever their age within the above limits. And further, it suggests a fever-distributor of great potency such as has heretofore been recognized as operating through water or milk.

2. *Incidence of the Fever in Time.*—This is dealt with in Table II.

TABLE II.

Harewood Terrace, Upper Part. Nos. 13 to 30 inclusive.

Time of Attacks.	Number of cases occurring.	Houses having Cases in them.
1881.		
Month of August - -	2	No. 28.
„ September - -	2	Nos. 28 and 20.
Early October - - -	1	No. 20.
Week ending 3rd December -	—	—
„ 10th „ -	13	Nos. 24, 22, 19, 21, 18, 30, 27, 29, 25, 17, and 20.
„ 17th „ -	11	Nos. 28, 30, 25, 17, 13, 15 and 20.
„ 24th „ -	5	Nos. 19, 17 and 13.
Early January 1882 - -	1	No. 13.
Aug. 1881, to early Jan. 1882 -	35	14 houses.

* Between the date of the above investigation and mid April three additional cases of fever occurred in the terrace. Two were in a house previously invaded, and one in a house at the lower end of the terrace, none of the cases were fatal.

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Two series of cases of fever in the terrace are here seen. A first series, consisting of some half-dozen cases occurring in two houses in August, September, and early October; and a second series, separated from the first by an interval of two months, constituting a sudden outburst of fever freshly and almost simultaneously invading 12 of the 17 households, and at the same time freshly attacking the two houses which had suffered in the autumn. It is this sudden outburst of enteric fever that requires explanation. Was this outburst independent of those earlier occurrences of fever about August and September, or was it, notwithstanding the two months interval between the two series, related in some way to those earlier cases? For answer to these questions it is necessary to pass on to the result of inquiry as to food and other personal conditions of the persons attacked in the outburst.

3. *Food Circumstances and other personal Circumstances of People attacked.*—In taking a census of the terrace for ends already evident, I made inquiry in each household as to the consumption of articles of food that might have conveyed infection, and as to the sources whence each had been derived. The food articles inquired about included meat, bread, and the like, besides milk. To the latter especial attention was given, for the reason that the suddenness and comprehensiveness of the fever incidence had been, as has been said, such as to suggest what has been termed a "milk outbreak." The result of this inquiry was altogether negative. The sources of supply of the above articles had, during the period in question, been very various, and it seemed highly improbable that infection could have been conveyed in food. For instance, households invaded had, inclusive of condensed milk, been getting milk from four separate sources, and this at the same time that other households in the lower half of the terrace, most of them also supplied from one or other of these four sources, had altogether escaped fever. Moreover, two of the invaded households had, for many weeks, been wholly without milk. Similarly, inquiry as to the habits and doings of individuals attacked tended to show that they had not contracted their illness away from home. The occupation of parents and the school attendance of children had been similar to, often identical with, that of inhabitants of the lower part of the terrace, who did not suffer at all in the outburst. Upon the whole, therefore, it became evident that the cause of the recent fever had not been suddenly or even recently transported to the terrace from elsewhere, and by a process of exclusion it began to appear that the cause of that outbreak was to be sought for in those earlier cases in the terrace which occurred about August and September. It became, in fact, apparent that infection-material from these earlier cases had been fostered within a limited area of the upper part of the terrace after a fashion that conserved it for a while and then permitted it to become suddenly operative within strictly defined limits in November and December. Thus regarded the first series of cases in August and September acquired considerable importance, and they had now to be considered along with certain physical circumstances by help of which they may have done mischief.

Precise knowledge of the cause of this first series of cases was not now to be had, nor is it essential for present purposes. This much may, however, be said. These cases, all but two of which were in children, occurred at a time when other fever cases existed a quarter of a mile off, at Norwood Green, and it is probable that some at least of them got their infection there. The Norwood Green fever was, the medical officer of health satisfied himself, due to specific pollution of the water of a particular well thereabouts, and I have been able to get evidence that

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the two children, the first of the inhabitants of Harewood Terrace to suffer fever, had, after playing on Norwood Green, drank water from that well about two weeks before their attack. Probably other children of the terrace, inclusive of other sufferers and of a doubtful case of fever, did the like, and it is noteworthy that the only adults suffering among the first series were two mothers who were attacked after several weeks attendance on their children sick of fever. It appeared probable, therefore, that none of the cases of this first series were due to dissemination in the terrace of infection in quite the same way that produced the December outburst.

4. *Physical Circumstances that may have conduced to the Outbreak of December.*—In both instances of households suffering in August and September the sick persons were treated at home, and their bowel evacuations were got rid of down their respective closets, whence they passed to a series of cesspools. It became a question, therefore, how far the cesspool conditions of the houses might have conduced to the subsequent outbreak in December. They might have done this in one or other of two ways; by conservation in the cesspools of enteric fever material which, eventually becoming suspended in cesspool air, finally escaped with that air from the whole series of cesspools into or about the houses, or, by soakage of this enteric fever material from the leaky cesspools into the soil and thence into the wells hereabouts. As to the first of these suggestions, it may be said that the cesspool system of the terrace appears specially adapted for the process. The cesspools, linked together as they are by overflow pipes, are practically one cesspool. Habitually they are overfull, and their connecting pipes, therefore, provided for the ready transference from a higher to a lower cesspool of any semi-fluid matter that it may contain. And in that each series of cesspools is unventilated, the overflow pipes must act in one and another direction as air-communicators between the cesspools.

Given, therefore, the introduction to one cesspool of infective material that can become suspended in air, the whole series of connected cesspools incurs a liability to become infected after a fashion that might enable each cesspool of the series to give off, under pressure by flushing, specifically infected air in its neighbourhood. Referring again to the plan it will be seen that something of this sort may very well have occurred, after infection of the cesspool serving houses Nos. 28, 29, and 30, in the terrace, to the A series of cesspools, and it will be seen that the distribution of this A series of cesspools pretty closely coincides with the distribution of the fever. But there are difficulties in accepting this hypothesis of causation of the outburst. It affords no sufficient explanation of the two months interval between infection of the A series of cesspools and the occurrence of the outbreak, or of the suddenness of that outbreak when it did occur. Again cesspool air would not have been forced out into the houses. These are disconnected from the cesspools and the cesspools therefore could only have infected the air of outdoor closets and the atmosphere about the houses so as seemingly to involve risk to other persons besides the inmates of houses served by the A series of cesspools. Thus the strict limitation of the outbreak would remain insufficiently accounted for. Finally, reference to the plan will show that house No. 13 is served by the B and not by the A series of cesspools. Nevertheless, the inmates of this house suffered coincidently with inhabitants of the upper part of the terrace from the December outbreak, whereas their next door and other neighbours southwards, at Nos. 12, 11, 10, &c., separated from them by a garden fence only, had no illness. This circumstance goes

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far to set aside a hypothesis of causation of the outbreak through cesspool air, and, as will presently be seen, it leads of necessity to consideration of sufficiency of the circumstances of water supply to account for the facts of the outbreak.

Very early in the investigation it was noted that the suddenness, the intensity, and the impartiality of the incidence of the outbreak best accorded with what is known of enteric fever epidemics caused by specifically infected water or milk. Milk causation of this outbreak had for good reason to be set aside, while as regards its possible causation by water there appeared at first sight a serious difficulty. The 14 houses invaded in the upper part of the terrace are provided with three pumps, each of which, it was affirmed, sucked from a separate well, and hence there appeared to be required for explanation of the outbreak by water causation sudden and simultaneous infectiveness of the water of three separate wells many yards distant one from each other and from the houses. This seemed a highly improbable occurrence, and thus some time was spent over the cesspool air hypothesis, until the great difficulties in explaining the attack of inmates of house No. 13 (which as has been seen is on a separate system of cesspools) furnished a clue of much value. It was found that pump No. III. which served houses Nos. 13, 14, 15, 16, 17, and 18, had at the date of the outbreak been for a long time out of order, and as a consequence the inmates of these houses had for many weeks before their illness sought water elsewhere. Naturally they resorted to the pump most accessible, which happened to be pump No. II.; for pumps No. IV. and No. I., which also they could have used, were, as will be noted from the plan, cut off from them, the one by a strong fence, the other by a brick wall. Thus it came to be seen that at the time of the outbreak all the houses invaded had been for many weeks getting their water supply from one or other of two instead of from three pumps as had been confidently stated. This reduction in the number of pumps, and therefore of wells, implicated did not however greatly help toward belief in water causation of the outbreak; for there seemed well-nigh as much difficulty in accepting sudden and simultaneous infection of two as of three wells. In this dilemma I sought to ascertain whether pump No. II. had not for some reason or other come into temporary and exceptional use shortly before the occurrence of the outbreak by the inmates of houses 23 to 30. But this suspicion had to be abandoned. Both pumps had been in good order throughout the period in question, and pump No. I., which is separated from pump No. II. by a brick wall, had been used and solely used by the inmates of houses 23 to 30; all of which houses had been invaded in the outbreak. Still I was unable to accept a hypothesis of sudden and simultaneous infection of two widely separate wells far distant from the houses and from the cesspools: rather I was disposed to regard the confident local assurance rsspecting pumps Nos. I. and II. sucking from separate and distinct wells as open to doubt; and thus it came about that I announced that for complete belief in water causation of the outbreak it was necessary that pumps Nos. I. and II. should suck from a single well. My surmise was quickly put to the proof by Mr. Freeman, the Inspector of Nuisances, with the result, a great surprise to certain inhabitants of the terrace, that the suction-pipes of Nos. I. and II. were found to lead to one and the same well.

Here, then, in infectiousness of a particular well water is explanation in some sort of the outbreak. It accounts for the limitation of the

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outbreak to the particular part of the terrace comprising houses 13 to 30, as well as for the intensity of the fever incidence on these houses; while it is in accord with the indications of Table I., which pointed to a fever-distributor of heretofore proved impartiality and potency. But it does not explain all the facts. There remains to be accounted for the two months' interval between the August-September series of cases and the outbreak of December; and especially does the suddenness of the outbreak, when it did occur, require explanation.

At an early stage of suspicion as to water causation of the outbreak and upon assumption of conservation in the cesspools of enteric fever material derived from the first series of cases with subsequent soakage thence of this material through 60 or 70 feet of soil to two or more wells, the above facts did not appear easy of explanation. But no sooner was a particular well found to be alone in question than a clue appeared that had been wanting. For thus considered it was seen that suddenness of the outbreak almost necessarily implied sudden infectiveness of the particular well, such as might have resulted from fresh conditions newly brought to bear on it, and upon it alone; and search in this direction now revealed the following facts:—On 27th November 1881 cesspool cleansing was commenced in the terrace and was repeated on subsequent days up to early December. The cesspools dealt with were three of the A. series next in order to that which received bowel evacutaions of the August-September series of cases, and the cleansing proceedings included transference of the contents of these cesspools to a hole newly dug in the garden some 40 feet from, on higher ground than, and in the line of natural soakage to, the particular well which has been called in question. Now the main outburst of the fever did not, as will be seen from Table II., occur until the second week of December, soon after the commencement of this cesspool emptying. Then, be it observed, and not till then, did any notable extension of fever in the terrace take place; and this, notwithstanding that the whole A series cesspools must be regarded as having fostered, ever since August, material presumably capable of causing enteric fever. The inference is not to be avoided, namely, that this exceptional transference of cesspool contents to a hole in the ground near the particular well speedily brought about specific pollution of the well water, and thus occasioned the sudden outbreak of enteric fever among persons using that well water.

Certain subordinate considerations remain to be noticed. They do not affect the above conclusions though they may have interest for the etiologist. It will be observed from Table II. that, allowing for the incubation period ordinarily observed in enteric fever, this outbreak followed very quickly on the procedure which is believed to have fouled the well. It would seem therefore that, either highly potent infective matter transferred from the cesspools to the soil of the garden passed at once into the well; or, in this particular outbreak, the interval of time between the occasion of infection and the first symptom of illness was in many persons abnormally shortened. Shortening of the incubation time may no doubt have occurred. It would be in accord with experience of certain milk outbreaks of enteric fever where consumers of large amounts of the implicated milk in a raw state have seemed to suffer fever within a very few days of their infective meal. And what is true of enteric fever conveyed by milk may be true also of enteric fever conveyed by water, for in both instances there is chance of infective matter of great potency getting applied directly and in abundance to the intestinal tract. In this outbreak there was in many cases the usual difficulty in exactly fixing the date of attack, but so far as I have been able to

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ascertain by personal inquiry case by case the early attacks occurred as follows:—

Doubtfully on or about 4th December, 7 days after commencement of emptying of cesspools - -	1 case.
In three days, 8th to 10th December, 11 to 13 days after commencement of emptying of cesspools -	12 cases.
In three days, 11th to 13th December, 13 to 17 days after commencement of emptying of cesspools -	5 „

The above facts are not, it will be observed, inconsistent with shortening of the incubation period, as regards the earlier cases, though abridgement of that period is not absolutely requisite for their explanation.

Upon the whole I am indisposed to accept such explanation, believing rather that infective matter passed directly to the well on, or within a few hours of, the 27th November; and for the following reasons:—The freshly dug hole in the garden to which cesspool contents commenced to be transferred on 27th November was situate, as has been said, some 40 feet from the particular well, upon higher ground, and in the line of natural soakage to the well. No doubt therefore the relative positions of the cesspool deposit-hole and the well, and the porous character of the gravelly soil intervening between them, were physical circumstances conducive to rapid passage of cesspool-derived liquid from the newly made hole to the well, though the interval of 40 feet, that had to be traversed by this liquid in getting to the well, seems at first sight to almost forbid belief in fouling in this way of the well within a few hours of commencement of cesspool emptying. But there are other circumstances to be taken into account before a decision is arrived at. From the plan it will be seen that the hole freshly made in the garden for the reception of cesspool contents was dug against a wall that runs toward and within three and four feet of the particular well, and that nearly midway between this hole and the well the suction pipe of pump No. II. passes immediately beneath the foundation of the wall on its way to the well. It canot be doubted that we have here special facilities for rapid passage of foul fluid from the recently removed cesspool contents to the particular well. Fluid matters poured against the wall would travel towards lower ground most readily and quickly along the foundation of this wall, and could be thus led in the direction of the well; and further, upon reaching a spot nearly midway between this starting point and the well, such liquid matters could gain access to the trench in which the suction pipe of pump No. II. had originally been laid, and following this new course alongside that pipe would be conducted directly into the well. Whether or not the above was the course actually taken by foul liquid matters soaking from the cesspool deposit-hole to the well cannot now be determined. Mr. Freeman sought to put this surmise also to the test, but he failed for the reason that the plumber who had meanwhile been employed in laying on the Norwood Water Company's supply to the terrace, had removed the suction pipes of the wells. In removing the suction pipe of pump No. II. the interval of ground between the cesspool deposit-hole and the well had become so greatly disturbed that trustworthy evidence on the above point was not to be had.

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No. 12.

App. A. No. 12.

On Enteric Fever at Sherborne; by Dr. Blaxall.

On a Limited Outbreak of Enteric Fever at Sherborne, Dorsetshire; by Dr. F. H. Blaxall.

In pursuance of instructions from the Board, I visited Sherborne on the 20th April to make inquiry into an outbreak of enteric fever reported to the Board by Mr. Chandler, Chairman of the Local Board, and the Reverend E. M. Young, Head Master of Sherborne School, as having occurred in the town and in the "school house." [I had on a previous occasion (1873) inspected Sherborne in connexion with a severe and fatal outbreak of enteric fever there.]

The fever, it appeared, had invaded three houses: one the school house, the others two adjoining houses (Mr. Adam's and Mr. Downe's) on the Parade, at the corner of Cheap Street and Half Moon Street. Also that a case of a doubtful nature had occurred in Mr. Dawson's house in Cheap Street. This case was attended by an unqualified man residing at Yeovil, I was therefore unable to get any reliable information respecting it. Mr. Adam's household consisted of 10 inmates, of whom two, aged respectively three and 16 years, were attacked on the 7th March, and a third, aged 21 years, on 21st March. The servant also was taken ill and sent to her home, but she is said not to have had fever. Mr. Downe's house contained only two inmates, one of whom (a young man) was attacked on 25th March. The school house is the residence of the head master and other masters, and of 81 pupils: with servants it has a total of about 100 inmates. Here six cases occurred amongst the pupils. One on or about the 7th March, two on the 14th of March, and one on the 1st, 5th, and 7th of April respectively. The school was broken up on the 11th of April, a week earlier than the regular Easter vacation, and I hear of no fresh case occurring amongst the pupils since they went home. In all, this limited outbreak was marked by 10 cases in three households. The cases were typical in character, but generally of a mild form, and none have proved fatal.

The head master informed me that throughout the term he had observed many residents at the school house to be out of health, looking sickly and pale, and some having diarrhœa or sore throats. Inquiry into the several channels by which enteric fever is usually spread went to show that the only community of circumstance peculiar to the infected houses in contradistinction to the rest of the town was their water supply, which was derived from a different source from that of the town supply. This latter is from a deep well, the water of which is pumped up to a reservoir, and thence distributed to the various streets; whereas the infected houses obtained their water from the "Abbey Spring," situated in "Kennel Barton," in the Combe Valley, about a quarter-of-a-mile above the school house. The spring derives its water from the surrounding hills of inferior oolite. The subsoil is charged with water standing at about the level of a small stream which runs through the barton. A basin has been sunk to the depth of eight or ten feet and the sides cemented, and from this basin the water is conveyed by pipes to an hydraulic ram at the school premises. The water is in part forced up by this ram to a large tank on the roof of the school house, and the remainder (including that part which gives water-power to the ram, but is not raised by the ram) passes on by gravitation from the ram receptacle to a small cistern in a rockery opposite the front door of the school house; and from hence it is led to a conduit on the Parade in Cheap Street.

The Medical Officer of Health after due investigation, attributing the outbreak to the drinking of this Kennel Barton water, lost no time in advising that its use should be discontinued, and the town water laid on

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in its place. This was accordingly done, and there has been no fresh case since.

It will be convenient to consider the course of this Kennel Barton water supply under three sections.

The first extends from the intake to the ram, and furnishes the water supply of three families, including nine adults and fourteen children, besides five or six children daily visitors at the house of one of the three families. Moreover from this section an indefinite number of school boys are supplied with water by a branch pipe led from the water main, before it reaches the ram, to the outside wall of the school house, where it is accessible to the whole school, numbering about 300 pupils, who are said to drink of the water freely.

The second section is included between the ram and the conduit, and supplies four houses, or about 117 persons, namely, the residents in the school house, in Mr. Adam's and Mr. Downe's, and in another house.

The third section is the conduit itself, which is resorted to by passers by, while certain families habitually send to it for their drinking water in preference to using the town water, which is sometimes turbid and discoloured.

With regard to the characters of the Kennel Barton water:—The gathering ground is in part occupied by streets, and is exposed to serious pollutions from houses and farmyards. I observed near the intake a very offensive collection of liquid manure. Further, three sewers here converge and empty into a sewer which runs through the barton, and was specially mentioned by me in my Report of 1873 as being of insufficient capacity to carry off the volume of sewage discharging into it. A sample of water taken from the intake basin was recently submitted for analysis, when it was found to give evidence of much organic pollution, and is described as a "somewhat dirty water," and "in its present state unsuitable for potable purposes" (*see* Note I.). Thus there can be no question that the water is far from being a proper water for drinking purposes. At the same time this pollution of the water at its source cannot be considered to afford an explanation of the special outbreak now in question, seeing that the fever cases were not distributed generally amongst the persons who drank of the water throughout its course, but were limited to three out of the four houses supplied with water from a particular section of it, namely, from the section between the ram and the conduit. This marked limitation in the incidence of disease pointed to some specially localised impurity of the water. Upon careful examination of the local circumstances capable of affecting the water here, I came to the conclusion that in this particular part of its course, the water had exceptional opportunity of being infected by sewer air before it was used for drinking.

The drinking water of the school house is derived from cisterns which also supply the water-closets. They receive their water from the large tank already mentioned as filled by hydraulic power, two of them are placed over the boys' closets at one end of the dormitory passage on the first and second floor, and the third over the servants' closet in another part of the house. Adjoining the boys' closets are the housemaids' sinks, and here are taps in connexion with the closet-cisterns; the sinks have pipes leading down to the drains, while overflow pipes from the cisterns discharge over them. At the time of the Medical Officer of Health's inquiry these sinks were very offensive. The water in the cisterns was thus exposed to a two-fold danger of sewer air gaining entrance into it, namely, from the closet-pan and from the sink. It was from these taps at the housemaids' sinks that the boys' washing jugs were filled. Later on, after the town water had been substituted for the spring water in the school, comparative analysis was made of that

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water (1) before it entered the boys' closet-cistern, and (2) as it was delivered from the cistern, and the analysis went to confirm the belief that there had been local contamination of the cistern water by organic matter. (*See* Note II.)

The pipe which supplied the school house with the water that was meant for drinking was led from the cistern over the servants' closet to the scullery, while the overflow pipe discharged into the open air. To what extent, if any, this lessened the danger of contamination to the water one cannot determine, but it is worth noting, inasmuch as no case occurred amongst the 19 masters and servants, whereas six cases occurred amongst the 81 pupils, and it is in evidence that the boys were in the habit of drinking water from their jugs, especially three of the sufferers. It is to this channel that the cases among the boys may with probability be attributed. [The question may arise as to whether the cases may not have been due rather to sewer air gaining entrance to the dormitories. The distribution of the cases militates against this opinion. The passages are 118 feet long by 3½ wide. The cases occurred in separate rooms, two only being situated near the closets, whilst the remaining four were well removed.]

With regard to the three other houses, they also are served from the part of the service that I have called the second section. The pipes conveying the drinking water were in direct relation with the closet pans of these houses. A branch pipe was led to each house from the pipe which afterwards discharges into the conduit, going first to the water-closet and then terminating at the tap whence the drinking water was obtained; thus the water lay dead between the closet and the tap. The closet pans were very foul, affording evidence of ineffectual flushing, for although water was always running into them the stream was small, while the pipes being open afforded great facility for the air of the sewer being sucked up into them, and so brought into direct contact with the dead water in the pipes which would be drawn for drinking purposes, occasionally after many hours' exposure to this pollution. The only house of the four which escaped infection was occupied by five people varying in age from about 34 to 75 years, none of whom drank water. On the other hand the infected families were water drinkers.

At the conduit the water was always running, so that, if any closet-air ever passed backwards from the three houses towards the conduit stream, there was but little danger of serious contamination to the water of the third section, that in the conduit. Probably this is the explanation of the freedom from disease amongst those who obtained their drinking water at the conduit.

The Surveyor and Inspector of Nuisances assured me that these four houses were the only ones in the town in which the dangerous connexion, here described, existed between the waterclosets and the drinking water.

The limitation of the fever to the few houses in which this defect exists points, I think, very significantly to the drinking of water contaminated by sewer air as the channel by which the disease was spread. Further, the evidence of the medical men established the fact that antecedent cases of enteric fever had existed in the town, affording opportunity for specific pollution of the contents of the sewer.

It appears that the town had been singularly free from enteric fever for many years until December last, when a case came under Dr. Davies's treatment that had been contracted at Yeovil, whither the sufferer went in good health in November and returned home on the 9th of December ill with enteric fever. A second case came under Dr. Davies's care on the 24th of the month, but he was unable to learn its origin. A third case came under Dr. Williams's notice on the

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11th February. The sufferer was a young gentleman, one of a family of eight including father, mother, four children, and two servants. He left home on the 19th January for one night, returning on the following day. On the 4th February, *i.e.*, 15 days afterwards (a period corresponding with the period of incubation of enteric fever), he complained of feeling unwell, and on the 11th, being much worse, Dr. Williams was called in. No other case occurred in this house or locality, and there can be little doubt that the fever was contracted the night he slept from home. The evacuations of the first sufferer were disposed of in a privy pit or buried, but the water in which the infected linen was washed went to the sewer. As regards the two succeeding cases, in one instance the bowel discharges were disposed of in a watercloset without disinfection, and so passed to the sewer, but in the other, after Dr. Williams was called in, the precaution of disinfecting the evacuations was observed. The sufferers all resided in the upper part of the town; the first in Cold Harbour, the second in St. Swithin's Street, and the third on Green Hill. The drainage from Cold Harbour and St. Swithin's is conveyed by sewers down Cheap Street, one on either side of the road, east and west. These sewers run a steep course till they reach Half Moon Street, when the west sewer immediately after receiving the drain pipes from Mr. Adam's and Mr. Downe's houses, on its way through a passage called Bow, joins the east sewer and forms the Half Moon Street sewer, which is very flat and very badly ventilated, and the Surveyor tells me it is subject to considerable deposit of sewage mud in it. Here it is worthy of note that in the early part of the year, January and February, the rainfall was very inconsiderable, so that the filth would have accumulated in this sewer to a very great extent, till on the 21st February, by the advice of the Medical Officer of Health, the sewers were cleansed. They had not previously been flushed since the preceding summer. The flushing is effected by damming the contents of the sewer at various places so that they fill with liquid, which is then rapidly discharged. But by this means the foul air is driven out at any weak traps or available openings, whether closet pipe or sink, and in this way there seems little doubt the specific pollution of the water was brought about, for it is a significant fact that two houses were simultaneously invaded about 7th March, 14 days after the flushing of the sewers.

In 1873 a wide spread and fatal epidemic in this town was traced by me to the direct communication then existing between water-closets and water mains, and the present outbreak affords a second illustration of similar evils appearing to result from the self-same cause.

On this occasion the outbreak was of very small dimensions, and this is a fact that is both instructive and satisfactory. For the Sanitary Authority has in recent years taken much pains to give effect to the recommendations that were the outcome of my former inspection, with reference specially to providing service-cisterns for flushing closets and to ventilating the sewers. The present small outbreak has occurred in just those few houses where efficient amendment had not been made in the water service and which were in connexion with a sewer remaining ill ventilated. For the rest, the operations of the Authority have resulted in marked improvement in the public health, for whereas formerly mortality from enteric fever was of annual occurrence, during the last eight years, since the carrying out of the measures above referred to, deaths are recorded in one year only, as will be seen by reference to the subjoined table; and this immunity from fever is confirmed by the testimony of the medical men. It may perhaps deserve mention that diarrhœa also exhibits a decrease, the deaths during the six years, 1868–1873, averaging 3·7 annually; while in the eight years, 1874–1881, they have numbered only 2·25 on the average of years.

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App. A. No. 12.

On Enteric Fever at Sherborne; by Dr. Blaxall.

TABLE of MORTALITY from Enteric Fever for a period of 14 years abstracted from the Registrar General's Death Returns.

Year.	1868.	1869.	1870.	1871.	1872.	1873.	Total Deaths in the Six Years, '68-73.
No. of cases -	1	2	4	8	2	22	39

Year.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	Total Deaths in Eight Years, '74-81.
No. of cases -	—	2	—	—	—	—	—	—	2

I attended an informal meeting of the Sanitary Authority, when I communicated to them my views as to the origin of the recent limited epidemic. I advised that the sewers should be thoroughly disinfected, the ventilation of them improved, and better provision made for flushing them; also that means should be provided for filtering the Board of Health water before delivery to consumers, and that every precaution should be taken to protect drinking water from pollution by sewer air or otherwise, and I urged that the drinking of water from sources so liable to contamination as the Kennel Barton spring should be discontinued. I further took occasion to point out, by reference to the death returns, that from time to time scarlatina had proved very fatal, and I showed the desirability of making suitable hospital provision for the reception of cases.

6th May 1882.

NOTE I.

The Metropolitan Laboratory,
32, Holborn Viaduct, London, E.C.
April 8th, 1882.

ANALYSIS of a SAMPLE of WATER received from the Rev. E. M. Young, M.A., (per C. Cleminshaw, Esq.,) April 3rd, 1882, labelled "Water from Spring supplying Tank in School-house."

	Results expressed in	
	Parts per 100,000.	Grains per gallon.
Appearance in 2-foot tube	Turbid.	
Smell when heated to 100° F. (37·7° C.)	Slight.	
Chlorine in chlorides	2·00	1·40
Phosphoric acid in phosphates	Traces.	
Nitrogen in nitrates	·3706	·2594
Ditto, equivalent to nitric acid	1·6077	1·1674
Ammonia	·0196	·0137
Albuminoid ammonia	·0442	·0309
Oxygen absorbed in 15 minutes at 80° F. (26·6° C.)	·0440	·0308
Ditto, four hours	·0840	·0588
Hardness in degrees, Clark's scale, before boiling	28·74	20·11
Ditto, after boiling	5·29	3·70
Total solid matter dried at 220° F. (104·4° C.)	39·40	27·58
Microscopical examination	Decayed vegetable matter, a few monads, some mineral matter.	
Poisonous metals	Absent.	

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Observations.—This is a somewhat dirty water and contains too much organic matter. This, however, appears to be chiefly in suspension, and I am of opinion that it is of vegetable origin, and is not derived from sewage contamination. In its present state it is unsuitable for potable purposes, but would probably be greatly improved by efficient filtration. The total hardness might be reduced to a great extent by treatment with lime.

(Signed) H. S. Carpenter, F.C.S., &c.

Note II.

Analysis of two samples of water from the school house, Sherborne :—

A. Direct from the town main.

B. From the housemaid's tap in the closet on the second floor drawing from the cistern supplied with the town water.

Appearance in 2-foot tube :—

A. Clear, slight greenish tinge.

B. Do. do.

One gallon of each sample yields—

—	A.	B.
	Grains.	Grains.
Free ammonia	0·	0·003
Albuminoid ammonia	0·	0·001
Chlorine	1·05	1·12
Nitrogen (as nitrates)	0·	0·
Total solid matter	25·2	25·9
Iron	Slight trace.	Slight trace.

The town supply is a very good water and quite free from contamination. The sample from the cistern gives decided evidence of having absorbed a small amount of sewer gas through the overflow pipes.

(Signed) W. F. Donkin.

St. George's Hospital,
April 18th, 1882.

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On the Occurrence of Anthrax in the London Hide and Skin Trades; by Mr. John Spear.

No. 13.

On the Occurrence of Anthrax amongst Persons engaged in the London Hide and Skin Trades; by Mr. John Spear.

This inquiry was decided upon on the receipt of a communication from Mr. Payne, Her Majesty's coroner for London and Southwark, in which the attention of the Board was asked to the occasional occurrence of malignant pustule amongst men engaged in the hide-warehouses and tan-yards of the Bermondsey district.

On commencing the inquiry I found that amongst those engaged in the trade the disease in question was generally attributed to mineral poisons (arsenic or corrosive sublimate, for analyses *vide* appended note D.) believed to be often used in the cure of the hides; and the verdict of a coroner's jury had shortly before been recorded to that effect. This view, however, apart from its want of accord with our knowledge of the effects of such poisons, had been sufficiently disproved by observations carried out by distinguished clinicians and pathologists at Guy's Hospital. In that institution a number of the cases had been treated; and their identity with malignant pustule, one of the clinical varieties of anthrax—a disease primarily of the lower animals—had been satisfactorily established. This disease, in connexion with its occurrence amongst woolsorters in the worsted manufacture, had been, it will be remembered, the subject of extended inquiry on behalf of the Board in the year 1880; and the present report may conveniently be regarded as a sequel to the one of that date.*

I propose now to deal with the subject under the following heads:—

I. The London hide and skin trade; its extent, and the nature of the operations in the raw material.

II. The disease (with the circumstances of infection).

III. The preventive and remedial measures that suggest themselves.

I. The Hide and Skin Trade.

1. Extent, &c.—Various statistics as to imports and exports, &c., I have placed in an appended Note (A.). They are derived partly from the Customs' returns, and partly from private sources, and will afford some indication of the extent to which hides and skins are dealt with in this country.

Description of the Raw Material, Sources of Supply, &c.: Foreign Hides.—The term "hide" is applied exclusively to the skin of larger animals, mainly of the ox genus, but including also the camel, the horse and others of the pachydermata. The collection of foreign hides is effected mostly through travelling agents, who purchase at local markets and bazaars, and forward the parcels to the nearest port. There the hides undergo a rough classification. First, according to the market for which they are best suited—English, Continental, or American; and secondly, (although this classification is not always carried out) according to their quality. "Dead" hides, *i.e.*, those of animals that have died of disease or of age (the latter a frequent occurrence in countries where oxen are mainly used as beasts of burden), are placed in this case amongst the inferior qualities, technically termed the "rejected," and sometimes they ostensibly form a class apart. Such

* Report on the "Woolsorters' Disease" in the Annual Report for 1880 of the Medical Officer of the Local Government Board.

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hides are of some special interest for the purposes of this inquiry since they will probably include those to which danger of infection attaches. From some countries, however, for the reason above indicated, they form a large proportion of the total number exported; and in such case the significance and utility of the distinction is obviously greatly diminished.

The *curing* process, technically spoken of as either "wet" or "dry," is carried out by the natives. The hide is first "trimmed" (the head and tail "piece" being removed) and washed, although the cleansing, as shown by the frequent appearance of dried blood, &c., is by no means perfect.

Subsequent steps in the "dry" cure vary in different countries and localities. The hide may be simply dried in the wind and sun in a place protected from too scorching rays (as in some parts of South Africa, of the West Coast of South America, Singapore, Penang, Java, Batavia); but it is usually first subjected to some chemical application, designed partly to assist in the cure, and partly to protect from the ravages of the "worm" (*Dermestes Vulpinus*). Thus it is steeped in a bath of brine (North West Provinces of India); or salt, or earth largely impregnated with nitre, &c., may be rubbed into the fleshy surface (parts of Bengal, Madras, and Bombay); or it is washed over with petroleum (Rangoon and Penang); or with a solution containing arsenic, and probably other chemical substances (China, and some parts of Bengal).* Many of the hides from Bengal are thickly coated with the mud of the country, apparently with the three-fold object of assisting in the cure by the salts which the mud contains, of protecting the hide from the too scorching rays of the sun during the drying process, and of adding factitiously to the weight. Those from Bombay again are brushed over the fleshy surface with a solution of lime.

When completely dry the hides are hard and horn-like, they are folded lengthwise, generally with the fleshy surface outwards; and after classification at the port of shipment as I have described, are packed in bales and forwarded, as part of a mixed cargo, to their destination. A bale contains, as may be anticipated, a very varying number of hides (from 50 perhaps up to 200). It is generally packed under hydraulic pressure, and is bound together by rope or iron bands. The bales from Madras come, however, covered with canvas; and in the case of a few shipped from Calcutta the outer hides (wrappers) are chosen from the inferior qualities, possibly from "dead" hides, so that the loss may be less in case of injury.

In curing by the "wet" process, powdered rock-salt is rubbed into the fleshy surface of the washed hides; or the latter may be thrown warm from the slaughtered animal into a strong brine. Later they are "stacked," *i.e.*, spread out one above the other, with a liberal sprinkling of rough salt between each layer. Liquid, extracted from the animal matter by the salt, runs from such a heap of hides, but the latter remain moist or "wet" for an indefinite time. A strong salty animal odour is always perceptible, but that of decomposition, as in the case of the dry hides, is generally absent. "Wet" hides, "stacked," as I have described, in the holds of vessels, are imported from South America (being in that case usually the sole cargo); they come also, sometimes rolled in bundles and sometimes loose, from Australia, South Africa, and the Continent.

Foreign (or Colonial) Skins.—The supply consists mainly of the skins of sheep and goats; but includes also those of other of the

* One large exporter at Shanghai dips, I understand, all his hides into a weak solution of "Cowan's specific" (arsenical).

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smaller ruminants; of rodents (especially rabbits), and of many of the carnivora. These skins, the vast bulk of which comes from Australasia and South Africa, are almost all sun dried; although salt, or arsenical solutions, applied to the fleshy surface, generally assist in their preservation. They arrive in this country tightly packed in bales, with or without a canvas covering; very exceptionally they come as "pelts," *i.e.*, with the wool or hair removed.

"Dead" skins of the sheep and goat are not, so far as I can ascertain, so common. It may be that the wool or hair, which has some value, is removed rather than the skin, in the case of death by disease; and this is the more likely as the skin itself is often of so little value that, if of very inferior quality, it would scarcely be worth the cost of carriage. The skin of the Van goat, the fleece of which appeared to be the most frequent source of infection in Bradford, is little known in London; and goat skins generally are not dealt with to any very great extent in England (*vide* Imports and Exports, appended note A).

Hides and Skins of Home Production.—These arrive at the tanneries or the fellmongers' yards fresh from the slaughter-houses or knackeries, or intermediately from the skin-market, and are then known as "market" hides or skins; or when sent from a distance they are slightly salted, then folded or rolled in bundles. They come uncleansed from blood, dung, and other impurities; and to the hides of oxen the horns are still attached. Any advanced decomposition of the skin spoils it for tanning purposes, but putrefactive odours are sometimes unpleasantly perceptible, and in the summer swarms of flies are attracted; this, however, being much more apparent in some yards than in others, is perhaps rather due to neglect of surface cleanliness. The hides of foreign cattle (mostly from Spain and America) slaughtered at Deptford, as well as those (mostly from the Continent) slaughtered at Islington, are sent fresh, day by day, to the Bermondsey Hide and Skin market, and are thence distributed to tanners in various parts. The Superintendent of the Deptford market informs me that no case of anthrax has, so far as he is aware, occurred amongst cattle landed there; and that all hides, horns, &c. sent from the market are "disinfected."

Horse hides are not dealt with to any large extent in London, and are mainly exported to the Continent.

2. The Manipulation of the Raw Material in this Country. *Foreign Hides and Skins.*—Vessels conveying hides and skins to the Metropolis unload at one of the London docks; or, if coming from Continental ports, perhaps in the river into barges, or at one of the riverside wharves. At the docks the hides are never stored, although skins may occasionally remain for some time, for there is little accommodation for them. They are, indeed, usually discharged from the vessel "over the side" (*i.e.* the side opposite the quay) into barges; and in any case, unless intended for immediate transhipment to Continental ports, are soon on their way in barges to the wharves in Tooley Street, on the opposite or south side of the river. Some of these wharves are in the hands of hide-brokers, and are then devoted to the reception of such goods. Others are, however, made use of, and then care is not always observed to keep hides, &c., apart from general merchandize.

If the goods have not already been examined on behalf of the Customs this is now done; a bale here and there being opened in the presence of the officer.

Should it be intended to "sort" the hides or skins this process is proceeded with—on the wharf usually, in the case of "wet" hides; in the case of "dry" hides and skins, in the neighbouring warehouses of

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the brokers to which for the purpose, and for the purpose of storage, the material is now removed.

A truck load of hides is placed before the sorter; he, with the assistance of a labourer standing opposite to him, opens each hide, estimates at a glance its weight and quality, and throws it to the appropriate one of the several heaps that are accumulating around.

There are only some thirteen regular sorters in the London trade; and their duties being various (having for example to sort *tanned* hides and skins, of which vast quantities are now imported) they are probably not employed a third of their working time upon the actual handling of the raw material. Each one, however, when engaged in sorting raw hides, is assisted in a regular way by a gang of seven labourers; viz., two to open the bales and to load and bring up the truck; one to open the hide with the sorter, as above described; two to tally (count, weigh, &c.), and two to "stack" the sorted hides and to lay out samples for the inspection of purchasers. When sold, and before being carted away, the hides are generally again packed in bales—a work in which the same labourers are employed.

In sorting skins somewhat less assistance is required.

When some classes of dry hides are being dealt with, and generally with skins, there is comparatively little dust, but when hides that are plastered as I have described with mud, lime, &c. are in hand, the amount is excessive. Small pains are taken, moreover, to avoid this; sorting often going on with a cloud of dust in a room where other men besides those in actual attendance upon the sorter are working, and where goods not of themselves so dusty, and which will have to be sorted, are stored.

The rooms are, as a rule, spacious and fairly well ventilated; but they are used as warehouse as well as sorting rooms, and too much space is often taken up by stored material. They are often also littered, to what would seem to be a needless extent, with dust, pieces of damaged hides, &c.

The process I have described above constitutes the legitimate and time-honoured method of the trade; but now, with certain classes of goods, to "sort" them has become a rare exception. Australian sheep skins are carefully classified before exportation, and the process here I am told is only repeated in about one-sixth of the import. Amongst hides, Calcutta "kips" (constituting by far the greater portion of dry hides), and Chinese hides, are now mostly sold in "original" bales; any sorting that may be necessary being carried out after the preliminary tanning operations.

In such cases then only a comparatively very few bales of a consignment will be opened, a few for the inspection of the Custom House officers, and a few more for inspection by the buyer, before the material is distributed to tanneries or fellmongers' yards as the case may be.

The operations of the tanner and the fellmonger are fully described in Dr. Ballard's report on "Effluvium Nuisances" in the Annual Report of the Medical Officer of the Local Government Board for 1876. The first processes, all that concern this inquiry, are thus spoken of:—

Tanning.—(1.) *Fresh English* (*Market*) *Hides.*—The horns being removed, "the first process is 'liming.' A tanner has in his yard a "series of lime pits which are worked in shifts. They are usually in "series of three, the first being an old pit, the last being a pit of "newly-made milk of lime, and there is one intermediate. The hides "to be limed are first laid one above another in the oldest of the three "pits. It is called in the trade 'backward lime,' and is therefore the "weakest (or the least caustic) of the shifts. Here they remain about

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"two days. They are then removed into the intermediate pit, where "they remain about three days, and then into the fresh lime, where "they remain another three days at least. Some tanners prolong the "liming process considerably beyond this period. The milk of lime is "made with 6 to 10 bushels of lime to the pit" (a pit containing some 600 gallons of water). "During this process the hides are "'hauled' daily. The 'hauling' consists in two men drawing out each "hide separately with hooked instruments, laying the hides one above "another at the edge of the pit, and then putting them back again. "This is done to secure an even action of the lime. The exhausted "lime pit is then emptied, the water being run or pumped out, and the "deposit laid in a heap in the yard until it can be taken away."

"(2.) *Salted Hides.*—These are treated in the same way as "'market hides,' except that they are usually first soaked for a day or "two before liming to get rid of the salt."

"(3.) '*Kips*,' (*i.e., Dry Foreign Hides*).—These come to the tanner in "bales and as hard as a board. Before being dealt with, therefore, they "must be softened. For this purpose they are put into pits of water "called 'soaks,' where they remain until they are sufficiently softened to "allow of further manipulation. Nearly all the kip tanners I have "spoken to tell me they prefer to use 'old soaks,' that is to say, the same "water is used without renewal over and over again for successive lots of "kips. Fresh water, however, is added when necessary." (Sometimes there is a series of soaks, the hides being changed from one to another as in the lime pits. Hooked instruments are used for this work, as for "hauling." The water of a "soak" may be changed daily or weekly or even less often). "They, the hides, then go to be 'stocked,' "that is to say, they are beaten with heavy hammers, like cloth stocks, "while a spray of water plays over them . . . . From the stocks "they go to the lime-pits, but being of thinner texture than English "hides, weaker lime is used."

Subsequent stages of the tanning process will be found described in Dr. Ballard's report; but as it can scarcely be supposed that infectious property of the hides could resist the prolonged application of caustic lime in the lime pits, it will be sufficient to enumerate them here:—1. The thorough scraping of the hide on the hairy surface, "unhairing;" on the fleshy surface, "fleshing." 2. Soaking in water, and in some cases in ammoniacal liquors, to remove the lime and to still further soften. 3. Prolonged immersion in the tan liquors.

The Fellmonger's Trade.—I obtained no record in the course of my inquiry of any case of anthrax amongst fellmongers, or leather-dressers; and this may probably be explained by the facts already stated as to the trade in foreign skins.*

At the wharves, however, two or three cases of infection, apparently originating in the handling of skins, occurred, and, as there is nothing in the nature of the first processes of the fellmongers' trade calculated to protect the workmen if infection be present, their occasional injury must be anticipated. This will be seen by the mere enumeration of the processes to which foreign skins are subjected. Sheepskins: 1. Soaking in water in order to soften the skin (in country places this is often done in running streams). 2. "Burring," *i.e.*, removing the

* The death of a fellmonger's labourer from "internal anthrax" was reported during the inquiry; but at the post-mortem examination that I was allowed to make the diagnosis was not confirmed.

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"burrs" which stick to the wool (effected partly by machine and partly by hand). 3. "Tainting," *i.e.*, producing in the damp skin, placed in a warm chamber, incipient decomposition, so that the pulling off of the wool is easily effected.* 4. "Pulling," *i.e.*, removing the wool. 5. Soaking the skin (now the "pelt") in milk of lime, preparatory to sending it to the leather dresser; and drying the wool in a hot air chamber before sending it to the woolstapler.

English skins and goat skins are somewhat similarly treated, except that "liming," *i.e.*, brushing cream of lime over the fleshy surface, which in a little time serves to loosen the attachment of the wool or hair, takes the place of "tainting."

A process by which sheep and goat skins are made into mats need scarcely be described, since the very best of skins, not likely to be from diseased animals, are selected for this purpose.

There are numerous minor articles of the hide and skins trades, besides what may be termed residual products; but space will scarcely permit more than an enumeration of those that seem to be most important in connexion with this inquiry.

Rabbit skins are imported in enormous numbers from Australia and New Zealand. From a certain class a common sort of fur is manufactured, the longer hair being first pulled off (unhairing). This operation is done largely by females; one of whom was the subject of an attack of anthrax that came under notice in the course of this inquiry. The fur of the rabbit is also largely made use of for the manufacture of felt hats, felt carpets, frieze, &c.; the "pelt" is reduced to gelatine and size.

"*Trimmings*" of hides, "faces," tendons, and odd parts of the skin are imported in large amount. They go to the glue and gelatine manufacturers.

Foreign Horns, Hoofs, and Bones, of which large quantities are imported, are apparently perfectly dry and free from odor, for it is said that if wet shippers are careful not to receive them. They come either in bags or loose in the holds of vessels, and like the hides are conveyed in barges to the wharves and warehouses in Tooley Street. They undergo a rough species of classification, a work performed by labourers, according to the purposes for which they are intended. Parts of the horns are converted into imitation tortoiseshell combs. Suitable portions of the long bones, into bone handles, bone buttons, &c.; the hoofs into imitation tortoiseshell; while parts not suitable to any of these purposes go to the manufacturers of size, animal charcoal, and artificial manures.†

The *By-products* of the tanneries, and the *Refuse* and dust of the latter and of the hide warehouses, have again various destinations. The "parings" and "fleshings" of the tanner are sold to the gelatine or size manufacturers; the hair, to the felt manufacturers or plasterers. The dust of the warehouse rooms, and the general refuse of the tanneries, including the sludge taken from the wash-tanks and "soaks," pass often direct to the farmers as manure. The fouled water of "soaks" and

* From what is known of the life-history of the anthrax bacillus, this process of "tainting" may be regarded as well calculated to produce first the germination of spores, and then the destruction of the organisms.

† The preparation of ordinary "superphosphate" would certainly destroy any contagium; this, however, is not the case with the manure known as "raw-bone meal."

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wash-pits is discharged into the drains, or, in country places, into the nearest watercourse. Sacking is disposed of in various ways—for the stuffing of cheap upholstery, in the manufacture of paper, &c.*

II. Anthrax amongst Persons Engaged in the London Trade.

The different classes of person engaged in the hide and skin trade of the Metropolis, and the extent to which, so far as I have been able to ascertain, they have suffered from anthrax, may be enumerated, in the order in which they come into contact with the raw material, as follows:—

Classes of Persons.	Cases of Anthrax.
Stevedore	1
Dock labourers	None ascertained.
Bargemen	Do.
Custom House Officers (no necessary handling)	Do.
Wharf managers and foremen	1
Wharf labourers	9
Sorters	(Two doubtful cases).
Sorters' labourers (being also warehouse labourers)	11
Merchants (buyers) and masters of warehouses, &c.	1
Carters	1
Tanners	12 (all but one being labourers engaged in the first process).
Fellmongers	None ascertained.
"Unhairers" (rabbit skins)	1
Persons engaged in various other minor or subsidiary branches of the trade (glue, gelatine, felt, manure-makers, &c.)	None ascertained.

Other persons may occasionally, in the course of their avocations, come into contact with raw hides—railway porters for example. I have not heard of any cases amongst them.

Two cases, however, were treated at Guy's Hospital, as to which there is no evidence of the source of infection. One of these sufferers was the wife of a dock labourer, but the husband does not appear to have been working amongst hides. The other was a child; nothing is recorded as to origin of infection, and the attack occurred so long ago (1873), that it was thought useless to attempt to recover the history.

In the above enumeration I have not confined myself to any period, but have included such cases as seem to be sufficiently authenticated. In point of time they have occurred as follows:—

Years.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883. (9 months.)	10 Years and 9 months.
Cases-	4	—	1	—	2	3	1	1	8	14	5	39†

* An outbreak of anthrax amongst the workers in a paper factory in Lower Austria was heard of during this inquiry.

† Including two amongst persons not engaged in the trade, and as to which no evidence appeared of the mode or source of infection.

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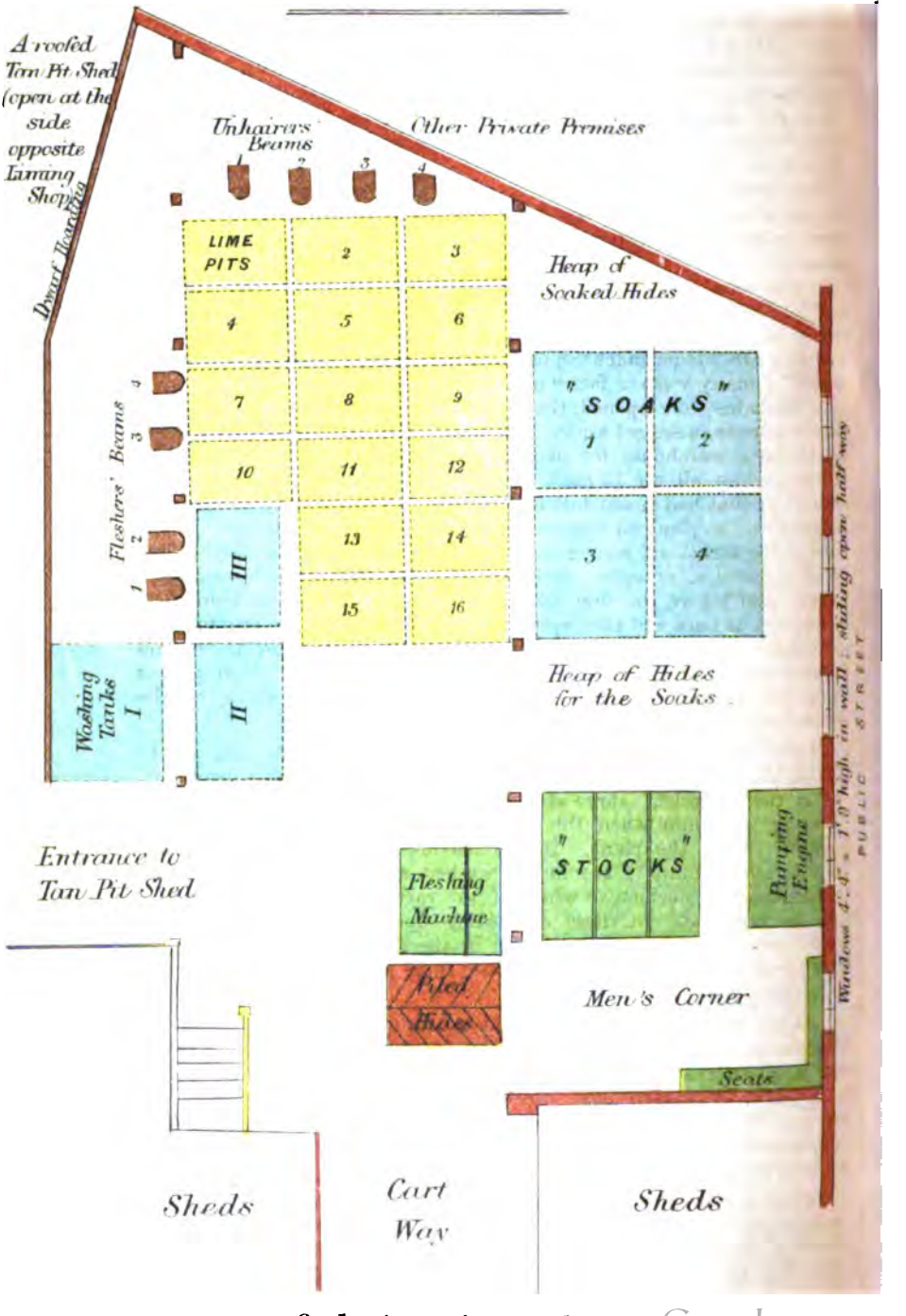
Messrs. Barrow's Foreign Hide Liming Shop.

Ground Floor of Two Storied Building

Height 10 feet



Scale 1/12 inch to 1 foot

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Dancerfield, Lith 22, Bedford St Covent Garden

Amongst the cases some important grouping was observed, the majority of those of recent date bearing evidence indeed of a common origin. In November, 1881, Messrs. Barrow Brothers, the largest tanners of foreign hides in Bermondsey, purchased through a broker 200 bales of what are known as "arsenicated China" (or Shanghai) hides. They arrived during the first half of January 1882, in three ships from Shanghai, in parcels of 35, 75 and 90 bales respectively; were discharged at the Royal Albert Dock, and conveyed in barges to "Butler's" wharf in Tooley Street. Thence the 35 bales of the first consignment were carted, unopened, on different days between January the 16th and February the 11th, to the tannery in the Grange Road.

They were deposited at the entrance of the liming shop (see accompanying diagram); and were there subjected, along with East Indian hides (a class constantly in hand), to the preliminary operations of tanning.

It was soon found that the Shanghai goods were of very inferior quality; the bales each contained, instead of about 80, over 100 hides; and a large proportion of the latter, besides being "light," were according to independent judgment, "dirty," "stale," "much tainted"; many were in fact "dead" hides.

As the bales were opened, the lightest hides, not suitable to Messrs. Barrow's trade, were set aside. On March 28th, 750 of these were sent to a broker's warehouse for disposal by public sale; and by the middle of April, when all the 35 bales had been disposed of, 250 more of the same kind, that had meanwhile accumulated, remained piled at the place indicated in the plan, waiting an opportunity of similar disposal.

As to the structural arrangements of this workshop, the part to the left is exposed to draughts, that to the right, where the "soaks" are situated, and where the first and most offensive process of tanning is carried out, is dark and close—defects which, owing to the proximity of the public street, are not easily remedied. Ventilation is further impaired when the entrance is partially occupied by a high pile of hides, and then, moreover, the men will often be working on the leeward side of possibly infective material.

Twelve or thirteen men are usually employed here, viz., six in soaking and liming (the men working indifferently at either operation), one at the "stocks," three at the "unhairing beams," two at the "fleshing" machine when this is at work, and two at the "fleshing beams." (Vide the plan). Before leaving the workshop the hides (now termed "butts") are finally washed, and are then examined by the foreman who decides to which of the various series of tan-pits they shall be removed. In these succeeding operations, those of tanning proper, some 200 men are employed by the Messrs. Barrow, but many other hides, English, Scotch, &c., besides those prepared at the workshop in question, come under their hands.

Between the end of January and the middle of April, whilst the Shanghai hides were being dealt with, six men employed in the workshop in question suffered from malignant pustule; three being attacked in January, two (both fatal cases) in March, and one in April; and amongst the large number of men engaged in the subsequent tanning operations one was fatally attacked on April 17. (Clinical records, &c., are in the appended Note B.; Cases 1 to 7 inclusive).

Five of the six men in the workshop were all known to have been engaged from time to time before and up to the date of attack in removing the raw hides to the "soaks," and in the case of four of them (the other was properly a "flesher") "soaking" and "liming"

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formed their ordinary employment. The sixth worked at the fleshing machine, close by the piled hides. He would stand in the dust arising during their disturbance; with, it was remarked by his fellow workers, the side of the neck on which the pustule appeared turned towards the hides. The seventh man, the tanner, worked at an entirely different part of the premises, and in ordinary course would not come in contact with raw hides, but only with "butts." He might, however, it is said, have visited his companions at the workshop where the other cases occurred.*

Another workman, not in Messrs. Barrow's employment, but who was engaged in carting the Shanghai hides from the wharf to the tannery, suffered likewise, at the beginning of February, from a slight attack of the disease (Case 8).

It will be remembered that a number of loose "light" hides were sent to a broker for public sale, and that others were stored in the liming-shop waiting similar disposal. The former, without any more manipulation in this country than was necessitated by their removal, were exported to Italy—390 to Catania, 238 to Genoa, and 122 to Naples, thence to be distributed to various small tanneries in the interior. Of these I have as yet obtained no further information. The 250 hides that were stored in the liming-shop were eventually taken, no opportunity for sale offering itself, to be worked up in the tannery. A few days after the work was commenced, and whilst it was still in progress, on February 1st 1883, another man, who was engaged in putting the hides to soak, was seized with the disease. (Case 9 in appended note.)

A dispute had meanwhile arisen between the Messrs. Barrow and the brokers (the exporter at Shanghai having failed) as to the ownership of the remaining 165 bales of the two other consignments. Messrs. Barrow thought not to receive them, still it was decided to sell if possible.†

Accordingly, between February 23rd and March 6th, 1882, eight bales were sent as a sample to a commission agent in Paris. Six parcels were returned on the 24th of the following April on account, mainly, it appears, of the inferior quality of the hides, but with a rumour also of mischief caused by them. Afterwards there came a definite intimation to the effect that seven men, two of whom had died, were attacked by "blood-poisoning" after handling the sample.‡

The remainder of the goods were offered for sale from time to time, and intending purchasers occasionally visited Butler's wharf, where they were still stored, to look at them. Three bales were thus sold on October 5th, 1882, being sent by the purchaser in "original" (*i.e.*, unopened) to Palermo, and 10 more on November 9th, nine of these going to Leghorn and one to Leipsic, all in the "original." No mischief is ascribed to those sent to Palermo; of the others nothing has yet been heard.

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* He stated to the surgeons at the hospital that a pimple, which he had been in the habit of picking with his nails, had for some time occupied the site of the pustule.

The corner of the workshop marked "men's corner" in the plan, appears to be regarded somewhat as a rendezvous by the men. Those employed in the shop often take their meals here, and here their coats are hung up during work.

† The dissatisfaction was mainly due at this time to the obvious condition of the hides.

‡ The seven persons believed to have been infected include, according to my information,—a merchant who examined the hides at the agent's warehouse; two warehousemen (one being the man who re-packed the hides for return to England); and four tanners, the latter working at three different establishments. A local pustule seems in each case to have developed. The merchant, and the man who re-packed the hides, were those fatally attacked.

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Messrs. Barrow have lately, June 1883, taken four or five more bales to their tannery, and during the same month 25 were removed to the brokers warehouse and sorted there. In these cases it has been explained to the men that the hides were suspected, and any sign of infection was watched for with the object of taking prompt curative precautions; no ill results have however followed.

At Butler's wharf the men were not so fortunate. On July 25th, 1882, a labourer was attacked by malignant pustule; another labourer on August 8th, and the manager of the hide department in December. (Cases 10, 11, 12, in appended note B.)

This wharf is mainly devoted to general merchandize and the trade in hides is comparatively small, only some eight men on an average being engaged, I am told, in that department. Other foreign hides were in store at the time of the above-mentioned attacks, but in each of those cases it was noticed that shortly before his seizure the sufferer had been employed, although not exclusively, in handling the Shanghai hides: the two labourers in moving them from one place to another, and the manager in opening the bales to show to intending purchasers.

All Messrs. Barrow's foreign hides are received at Butler's wharf, so that there would be nothing absolutely inconsistent with the supposition that East Indian and not the Chinese hides were the vehicles of infection in the London series of cases. The fact, however, that there was entire freedom from disease through all the long period when East Indian hides were alone being dealt with, and that mischief arose on different occasions, in the warehouse, in the process of removal, and in the tannery, just when the others were taken in hand, goes far to negative this supposition; and, as regards the attacks in France, the Chinese hides were the only ones sent by Messrs. Barrow to that country; so that if any connexion existed between the two series of attacks, which can scarcely be doubted, it can only have been through the Shanghai hides.

The export of hides from China is subject to "seasons;" the seasons alternating with and being in large measure determined by those of the tea trade. The 200 bales bought by Messrs. Barrow were the first of a particular brand, and from a particular exporter, to arrive in this country during the season of 1882. Later in the season there came to London from the same exporter 269 bales, but these were all again exported, to Italy, Sicily, Bavaria, and other parts of the Continent; the classification or sorting of the hides being effected in this country in the case of only 22 of the bales. The manipulation here, such as it was, does not seem to have resulted in any mischief, and of the bales sent abroad I have only as yet heard of 27 which went to Leghorn. The evidence in their case was again negative.

The condition of the first (Messrs. Barrow's) consignments would seem, however, to suggest that contemporaneous hides must be looked for amongst those of the previous season, and on doing this some further evidence of infection appears. In 1881, 335 bales, so far as I can ascertain, of the same brand of hides were imported; 50 of these were bought by Messrs. Barrow, and the remainder were again exported, all "in original," to various parts of the Continent. Whilst those received by Messrs. Barrow were being dealt with, in the workshop, and in the method, already described (East India "kips" being at the same time in hand), two men who had been engaged at the "soaks" were attacked by malignant pustule (Cases 13 and 14 in appended note); one in July and the other in September. The first (No. 13) had left Messrs. Barrow's employment on July the 2nd, and (meanwhile out of work) noticed the pimple on July the 6th.

It has seemed reasonable to particularize thus far one *brand* of hides: for it may be assumed that the goods of a particular exporter may be

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drawn largely from certain districts, and, again, that one exporter may be less careful than another of the class of goods he receives. Looking, however, at other consignments from China, evidence is found suggestive that they also have been productive of some, although less extensive, mischief. Exclusive of the brand already spoken of, some 700 bales were imported during 1881, and some 1,300 during 1882. They were received by three different firms of brokers here, but with the exception of a few small parcels that found their way to Hull, Leeds, Glasgow, and perhaps one or two other provincial towns, were again exported to various places on the Continent. At one of the London warehouses where they were received (Messrs. Flack and Chandler's), where some 25 labourers on an average are employed (only about half of these however working on "raw" material), three men suffered from malignant pustule during the present year (1883); one being attacked on February 15th, one on February 22nd, and one on July 26th (Cases 15, 16, and 17 in Note B.). Hides from almost all parts of the world are received in this warehouse, but it was noticed by two of the sufferers that they had been from time to time for some few days before their seizure engaged in moving or showing to intending purchasers (unpacking and repacking bales) Chinese hides. The other of the three cases was a fatal one; the sufferer had stated at the hospital that he had been employed on Chinese and East Indian hides and Australian sheep skins.

At Messrs. Anning and Cobb's warehouses, where fewer labourers are employed, one of the men suffered in January of the present year from a fatal attack of what I think there can be little doubt was "internal" anthrax (Case 18, page 112). For three days prior to his seizure he had been re-packing the Chinese hides.

These hides would be of the 1882 season. Consignments were being landed at the "Gun and Shot" wharf in October 1882, for both the two last-mentioned firms. A wharf labourer employed partly in this work, and partly in landing sheepskins, was attacked on the 27th of the month (Case 19 in Note B).*

In view of this evidence, the trade in hides in China, and the occurrence of the anthrax disease amongst the native animals, have some special interest.

The hides are almost exclusively those of oxen, and are derived mainly from Mongolia and the district around Hankow. They are shipped in a partially dried condition, in local steamers and other craft, at Tinsin or Hankow for Shanghai; where, along with the comparatively small number of hides collected around that town, they undergo the process of curing (the application in some form or other of arsenic) which I have described. In this trade some hundreds of coolies are employed; they work in gangs under native managers, and the European employers are not, I am told, likely to hear of sickness or death amongst them unless something particularly striking occurs.

From the experience of those who have studied the subject of anthrax from the point of view of its geographical distribution, it is known that the disease affects sometimes the Chinese cattle, (Flemming in his work on Veterinary science speaks of having seen it in the north of China in

* Apropos of the trade with the Continent, in the course of my inquiry I heard of recent cases of "blood poisoning" amongst tanners at Massina and Genoa. The mischief was ascribed to arsenicated hides, but whether Chinese or not I cannot say. Somewhat earlier attacks were also heard of in Prussia.

A larger number of Chinese hides are exported to America than to this country; some also go direct to Germany, Italy, and France.

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importance one may to these cases, it must
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11 months taken for exact observation,
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with. It was found also that in the preceding April two of a flock of 40 sheep, after two days occupation of the same marsh, had died suddenly; and that in the early part of the same year two heifers, pastured in the field on the opposite side of the ditch, were found dead.

The carcass of the cow first spoken of was buried six feet deep and covered with lime; the 11 remaining cows were removed for a period of 14 days, and the tan-yard drainage meanwhile diverted.

In the following November, when the 11 cows had been some nine weeks again on the field, one was found dead in the ditch (no signs of a struggle being present to justify the supposition of drowning); and on December the 12th another was found dead. The Messrs. Edgar, being this time appealed to, again showed that the disease was anthrax. They noticed at the same time that the ditch was still much polluted with tan-yard refuse, their directions as to cleansing having been neglected. These directions were then followed, and animals pastured again on the field after an interval of three months came to no harm. The farmer has, I understand, obtained compensation from the proprietors of the tannery.*

In January 1881, a heifer died on the home-farm belonging to the proprietor of the tannery; and Mr. W. Alston Edgar found at the post-mortem examination that the lesions were "most strongly "indicative of anthrax." Decomposition had, however, considerably advanced; and, experimental inoculation affording no results, a positive opinion was withheld. Subsequently two more deaths on this pasture occurred, the cause being referred to "pulmonary hyperæmia produced "by tympanitis from impaction of rumen." The animals were known to have had access to a corner of the field where several cartloads of refuse from the tannery were deposited.

In bringing the remaining cases of the disease amongst hide-workers that formed the subject of this inquiry under notice, I will reproduce a tabular statement contained in a paper published by Mr. Davies-Colley, surgeon to Guy's Hospital† (Table appended, note B). With the author's permission I have brought this table up to date, adding such cases as are known to have come under the notice of private practitioners, and, where possible, amplifying such details as tend to throw light on the source of infection.

In each of the 38 cases of malignant pustule recorded in the table, the lesion appeared on some part of the body habitually uncovered; the exact position being as follows:—

Neck (including inferior surface of chin), 16; cheek, 12; eyelid, 2; chin, 2; lip, 2; forehead, 1; forearm, 3.

In my report on the woolsorters' disease I brought forward evidence tending to show that the virus of anthrax did occasionally produce local effect upon the fingers and hands; although the resulting pustule did not in that position assume a typical appearance, and had not accordingly been generally recognised. (Vide Memorandum on the

* The Messrs. Edgar tell me that in their predecessor's time the fields nearer the tannery were periodically irrigated by tan-yard drainage; and that between the 7th of May and the 13th of July 1863, four cows of a herd pastured there died of what was pronounced at the time to be "blood-poisoning produced by the tan-yard washings." At the latter date the herd was removed to a distant pasture, and the fields are now converted into arable land.

† "Notes of two cases of malignant pustule, together with a table of 17 cases treated at Guy's Hospital, by J. N. C. Davies-Colley, M.D., Surgeon to, and Lecturer on Anatomy at Guy's Hospital." Vol. LXV. of the Medico-Chirurgical Transactions, London.

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Clinical Features of the Woolsorters' Disease, Note C.) Some evidence is forthcoming that this also has been experienced amongst hide workers.

Dr. Francis Boney, who contributes an account of a fatal case of malignant pustule, writes: "A number of bad wounds (fingers and hands) "came under my care soon after this man's death, among the men engaged "in skin work at the wharves. In all the cases the first sign was itching "of a scratch, then a characteristic papule, then inflammation of absorbent "glands."

Mr. Charles Gibson, of Wetherby, near Leeds, writing of two cases of malignant pustule that he observed in that town amongst workers in a foreign-hide tannery, says: "The second case was of the hand; much less "severe in constitutional effects, but involving the formation of "secondary thecal abscess. The pustule was on the back of the hand, "and was much smaller and less painful than the one, in the other case, "on the neck."

The following case of "Acute phlegmon of finger, with gangrene of hand," treated in Guy's Hospital, may likewise be recorded in this connexion:—

E. D. (aged 43), admitted under Mr. Lucas' care to Guy's Hospital on November 6th, 1880. Patient works in a tan-yard, and has the first handling of hides, many of which are said to be "stale." States that men are apt to prick their fingers with hides, and that "gathered" fingers are very common. October 29th, 1880, pain in right forefinger, so as to be unable to work. Same evening finger swelled; patient came to hospital surgery. Came again on October 30th, and on 1st and 6th November. Meanwhile had been poulticing. On 6th November patient admitted; two sloughs on outer and palmar aspect of index finger, dorsum of hand red and tense. Under chloroform, three incisions were made in latter position. November 9th, a large wound on back of hand from sloughing of skin; one incision with sloughing edges, another with a slough at the bottom of the wound. A little swelling of the arm at outer side. No brawny swelling; no constitutional symptoms. 10th, tendon on dorsum of finger exposed. 13th, gangrene of dorsal and palmar aspects of lower two-thirds of index finger, except tip. Bone bare. Index extensor tendon on hand sloughing. 19th, all swelling gone from arm. Health good. 22nd and 23rd, slight attack of tonsilitis. December 3rd, index finger extensively sloughed and bone exposed. House surgeon instructed to amputate at metacarpal joint. Chloroform administered, but before patient completely under its influence, pulse suddenly stopped and he died.

It is not improbable, however, that certain of the minor cases of local festerings may be attributable to the action of the poisons used in the cure of the hides by absorption through slight abrasions of the skin. Other symptoms suggestive of the constitutional effects of arsenic, smarting of the eyes, dryness of the mouth and lining membrane of the nostrils, in one or two cases periodical attacks of colic, were heard of.

I am not at all sure that the list I have given of cases of anthrax even approaches completeness. Dock and wharf labourers are notoriously an unstable body of men. They are engaged day by day and paid by the hour; and should any individual be absent or disappear it is no one's business to inquire of his whereabouts. Their work is various, often being engaged upon many classes of goods besides hides, and the mortality statistics of the occupation are unavailable, since, in death registers, the general term "labourer" is too commonly employed. In considering whether medical testimony can be relied upon for completeness of information in this regard, the course of the disease in the most important class of cases, that of the "internal infection," is to be remembered. The course is such, so insidious in invasion, so sudden in termination, that it seems almost unlikely that sufferers would often be taken to hospital; and the nearest medical aid is often only sought at a

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period too late for exact clinical observation. This was the experience at Bradford, even when public attention had been called to the occurrence of the disease; much more then is it likely to be the case in London where hitherto this form of the infection (without cutaneous lesion) has not been recognised. Drs. Goodhart and Mahomed, pathologists to Guy's Hospital, are of opinion that such cases have not in earlier years been entirely absent from the post-mortem table of the hospital. The following is the record of a case, for example, that is looked back upon with much suspicion :—

J. W. (aged 45), admitted to Guy's Hospital on June 5th, 1878, under the care of Dr. Goodhart. Patient works at the wharves, carrying sacks. History on admission :—First felt poorly last Sunday (three days ago), when he was taken with slight abdominal pain, lasting about a quarter of an hour. This recurred on Monday and Tuesday (yesterday). Yesterday evening was seized with intense pain, which continued until admission. Bowels open on Sunday and Monday. Yesterday took two pills; motion, small and very dark. Took last meal on Sunday; only milk since. Since last night there has been vomiting.

On admission at 2.45 p.m., patient collapsed. Face pale; lips blue; extremities cold and livid; pulse scarcely perceptible. Groaning with intense pain, and legs somewhat drawn up. Abdomen contracted and rigid; no excessive tenderness; mind quite clear; chest normal. Became more and more collapsed, with cold sweats. Died 7.45 p.m.

Autopsy. No general peritonitis (congestion in parts). Eight or nine ulcers in small intestine, small in size but larger towards cæcum. They presented a sloughy black surface, on removal of which the wall of the intestine was found to be thinned. Intense congestion around and upon the corresponding peritoneal surface. Similar ulcers in large intestine; one, in splenic flexure of colon, very large, and involving nearly the whole circumference of the gut. Peyers glands, healthy; spleen, soft; heart, lungs, kidneys, healthy.

In the practice of private medical men a few cases of suspicion have likewise occurred. I record below the history of a recent case in point. This, so far as one may now judge, would appear with extreme probability to afford an example of the internal form of the disease; and the manager of the hide warehouse where the man worked told me of a similar death (the history of which I could not, however, accurately ascertain) that occurred in the same employment three years before.

Case 18 in Table :—T. D. (Æt. 44). A sorter's labourer; very strong and healthy. On Friday morning, January 9th, 1883, felt a little poorly, with shivering, nausea, and pain in the back. Seemed all right on Saturday, and went to work as usual; went out also in the evening. Early on Sunday morning aroused his wife saying he felt very unwell, and as if he were "lock-jawed." Had a poultice on his neck, which seemed a little puffy, but there was no pimple or sore. That day had some difficulty in swallowing, but nevertheless took what there was for dinner. On Sunday night was constantly tossing to and fro in bed and got no sleep. Towards morning vomited repeatedly; extremities became cold and lips blue. At 10.30 a.m. the doctor first saw him. There was then oppression of breathing, cyanosis, and the muscles of the back were in a state of rigid contraction. At intervals through the day and the following night the patient seemed easier, but vomiting was frequent, oppression of breathing and great restlessness were frequently recurring, and the body was bathed in a profuse and fœtid perspiration. At 6 a.m. on Tuesday his wife, thinking he was dying, sent again for the doctor. The patient was gasping for breath, was blue in the face, and the extremities were cold. He again rallied, but died apparently asphyxiated at 10.30 a.m.

The ears, neck, and chest were found soon after death to be purple and swollen.

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Attaching, however, what importance one may to these cases, it must be admitted that the London experience is very different to that of Bradford. There, during the 11 months taken for exact observation, the proportion of fully developed attacks of "internal" anthrax, or anthrax fever, to those of the external variety (although including amongst the latter two cases in which the malignant pustule seemed to follow general infection) was as 23 to 9; and in earlier years the preponderance of the former class appears to have been even greater.

It is very generally opined that the clinical varieties of this disease are determined by the accident of invasion—that in external or cutaneous and in intestinal anthrax, infection occurs by local inoculation of a "fixed" virus; in anthrax fever, by the invasion of the respiratory organs by volatile particles. It is interesting to see how far this explanation will account for the discrepancy between the London and Bradford experience.

The woolsorters' handling of the material which is for them the vehicle of infection is certainly the more *intimate*. They have, in the process of sorting wool and hair, to separate fibres that may on occasions be matted together by dried blood or discharges—a disturbance of possibly infective material obviously tending to aërial contamination, such as is not so necessarily caused by the manipulation, as I have described it, of hides. As a matter of fact, however, in the latter process, by the rubbing of the hides one against the other, &c., and by the roughness of the handling, much disturbance of surface impurities, as indicated by the amount of dust, goes on. In watching the work one cannot but consider that the explanation suggested is but a partial one, so far as the dry hides are concerned; in the case of "wet" hides, or when those cured in the dry way come to be "soaked" in the tanning processes, other agencies, of course, that may lead to a real fixity of the virus, operate.

As regards greater liability to aërial infection by reason of closeness of atmosphere, &c., I cannot say that the London warehouses have in this respect any superiority over those in Yorkshire; in both cases the rooms are themselves large and well ventilated, but in both space is often too much taken up with stored material; and in respect of the danger of infection through the alimentary canal, the practice of taking meals in the warehouses, and with unwashed hands, seems to be as prevalent in one place as in the other.

The doubt as to whether variations in the type of the disease can be ascribed to the accident of invasion is somewhat heightened when it appears that differences are not limited to the phenomena of the early stages. The "woolsorter's" disease, excluding from consideration certain apparently rudimentary attacks, was shown to be a very fatal malady; a condition of general infection being, moreover, the usual, apparently all-sufficient, cause of death. The experience of "external" anthrax at Guy's Hospital has been so different that, regarded as a constitutional infection, the disease, as it has been witnessed there, may almost be spoken of as benign. Thus, of 20 cases in which constitutional symptoms were present, death occurred in five only, and in three of these the result was apparently due to so purely a local condition as mechanical interference with respiration by the œdema resulting from the cutaneous pustule (Cases 7, 37, 38, of appended note B.). In the two remaining cases an extensive enteritis, with ulceration, had been established, and probably contributed materially to the fatal issue (Cases 16 and 34). The experience at the hospital in fact is such that, although constitutional symptoms be markedly present, the greatest faith is placed upon the extirpation of the local pustule; and in one remarkable case (Case 15) published fully at page 118, bacilli were found in the perspiration, saliva, urine, fæces, &c., the patient meanwhile exhibiting only occasional transient symptoms of illness.

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These observations seem to imply either an inferior virulence of the virus itself, or a toleration of its presence such as we are not accustomed to witness in cases of "internal" anthrax. In support of the first possible explanation, the fact, now apparently well ascertained by pathological experiments and by studies of the naturally-acquired disease in animals, that the infective capacity of the anthrax bacillus is not uninfluenced by the medium in which it has developed in immediately preceding generations, might be advanced; and the second is recommended by the likelihood that some toleration on the part of the infected organism will be acquired during the slower inception of the virus in the external form. Or, again, there would be considerable show of reason in the argument that a local lesion is always developed at the point of inception of the virus, whether this be the skin or the bronchial or intestinal mucous membranes; and that since the bacillus cannot readily multiply in the circulating blood but must be continually reinforced from local foci of development, these latter, represented by the initial lesion, and varying in infective capacity according to their anatomical seat, constitute the governing principle of the disease.

The two last-named hypotheses afford, however, it will be seen, no explanation of the circumstance that tempted this discussion, the apparent immunity of the London workers from fatal attacks, relatively so common amongst the Yorkshire men, of "internal" anthrax.

It may be remembered that in the "Woolsorter's" report I brought forward considerable evidence, derived not alone from Yorkshire experience, to the effect that certain alimentary substances exerted an inimical influence in determining the course and severity of the constitutional infection; and that to this influence, if admitted, the woolsorters, from peculiar customs of theirs, had been specially subject.

III.—Remedial Measures.

The possible precautionary measures that may be taken to guard against the danger of anthrax infection from hides and skins, may perhaps be thus stated:

1. The establishment of an organization by which this country may be warned of the existence of the disease amongst the cattle, &c., of foreign lands; so that importation of hides and skins therefrom, or of "dead" hides and skins only, since danger must mainly rest with that class, may be prohibited, either absolutely or under certain restrictions as to previous disinfection, &c.
2. The general adoption of some process of *cure* which would serve not only to protect the skin from the ravages of the "worm," but would lead to the destruction also of morbific germs.
3. Failing this, a classification at the place of export (where classifications are already made for trade purposes), by which "dead" hides, &c. would be kept apart, to be dealt with afterwards under strict precautions.
4. Certain prophylactic or palliative measures, applicable to individual workshops, and individual workers, to be hereafter referred to.

As to the first of these suggestions, occasional Consular reports, and the reports of the Veterinary Department of the Privy Council (both, however, dealing mainly with those countries from which live cattle are exported) already afford some information of the kind needed, although not hitherto used for the purpose named. By other countries, I am told, Holland and America for example, an endeavour has been made in the direction indicated by requiring declaration before their consuls, by exporters, to the effect that the animals of the country whence the hides in question are derived are free from epizootic disease. The spirit of this regulation, however, is, it is believed, easily evaded; and it is pointed out that when hides are derived from remote parts the exporters must often be entirely ignorant of the condition of the native

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cattle. The information needed for the carrying out of the first of the above suggestions would often, no doubt, be at fault, whatever were the arrangements made; for anthrax amongst cattle exists not only as an occasional widespread epizootic (in which case the country most concerned usually endeavours to provide against the dealing in infected material) but also as an enzootic; causing almost annually a certain mortality, but a mortality too moderate to attract more than local attention.

The second suggestion would be promising were it not for the extraordinary power apparently possessed by the spores of the bacillus anthracis to resist chemical agents. It might, however, be possible so to treat the skins by a preliminary process as to cause any attached spores to germinate into the easily destructible rods. However this may be, the attempt to provide what would at the same time be a method of preservation and of disinfection seems well worthy of being made; and is the more likely to be successful since the present processes of preservation are not regarded by merchants as at all satisfactory, and any change offering fair prospect of success would accordingly be welcomed.

The *classification* of the material, so that "dead" hides and skins should be kept apart, might probably as a general rule be brought about were buyers to insist upon it. It would result in the limitation of dangerous material mainly to one class of goods, instead of its distribution throughout the entire bulk.

The above suggestions refer, it will be seen, to the measures that it would be possible to take before importation of the goods, and of these the second is the only one that, under the most favourable circumstances, could be expected to afford any complete measure of protection. As to precautions applicable in this country, it must be observed that already, in the exigencies of the trade, the handling of the great bulk of the material is reduced almost to a minimum. The greater part of the dry foreign hides (the source apparently of greatest danger) are now simply removed to the tannery and then soaked in water, before being subjected to those processes which may be expected to result in their disinfection. To diminish danger from handling in such case it could perhaps only be suggested that the bales, instead of being first opened, should be steeped bodily in the water, the bands being cut after immersion; and that on special occasions to the water of the "soaks" might be added some "disinfectant," or some agent that would render the fluid an unsuitable medium, at any rate, for the cultivation of bacilli.

In Italy a system of *inspection* of the hides has been attempted, with the idea that the disease may be detected by the appearance of the skin. In animals, however, cutaneous localizations are exceptional; and even when present it is to be doubted whether by their mere appearance they could be distinguished from similar conditions arising from other causes. The system, moreover, necessitates considerable handling of the hides, and has, I believe, been abandoned.

The process of "sorting" should not be undertaken when any special reason for anticipating danger exists; and in any case should be so carried out as to avoid the unnecessary disturbance of matter in the form of dust attaching to the hides or skins.

The sorting-room should as far as possible be used exclusively as such. It should be well ventilated, and well lighted; the walls, &c., frequently limewashed; and dust, pieces of damaged hides, &c., carefully removed after each day's work. The same scrupulous cleanliness should be observed in the warehouse-rooms, and in tannery workshops. Those of the latter in which hides are first dealt with should be especially well cared for, and abundantly ventilated and lighted. Experience seems

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to show that ordinary sanitary precautions of this kind go far to secure immunity from the danger in question.

I would, however, place in the very first rank of defensive measures, the dissemination of a knowledge of the danger amongst workmen, and of the precautions that are necessary to be observed in the first symptoms of attack. Experience continues to show that the disease is amenable to early and proper treatment; to favour the hope that the Greek sorters in their belief (referred to in my "Woolsorters'" report) that, under such favourable conditions, "no man need die of 'dallack,'" may not be mistaken.

One of the largest firms of hide brokers in London (Messrs. Dyster, Nalder & Co.) have already taken measures to forward the last-named object by issuing for the information of their employés a description in simple language of the disease, with plain instructions, in which I fully concur, as to the precautionary measures to be observed. (These instructions are reproduced in the appended note D.)

Before concluding this report, I would wish to express my great obligation to the many gentlemen who have assisted me in the inquiry. The merchants and manufacturers, many of whom are mentioned in the report by name, have, with a single exception, unreservedly placed their information at my disposal, and opened their manufactories and warehouses to my inspection. To the staff of Guy's Hospital, also, to Mr. Lockhart Stephens, the late house surgeon, and to many of the medical practitioners of the Bermondsey district, I am especially indebted for valuable assistance.

September, 1883.

NOTE A.

The Foreign Hide and Skin Trade.

Imports into the United Kingdom, 1882.

Hides: Raw, Dry:—

	Numbers (approximate).
From the East Indies (ox and cow)	4,050,000
,, do. (buffalo)	194,720
,,* China (ox and cow)	142,100
,, Java	52,307
,, Madagascar	42,930
,, British Possessions in South Africa	296,649
,, East Coast of Africa (Native)	53,605
* ,, United States of America	110,188
* ,, Brazil	56,561
* ,, Argentine Republic	16,650
,, Straits Settlements	539,655
,, Aden	45,400
,, Russia	41,400
,, Denmark	2,280
,, Germany	125,062
,, Holland	125,697
,, Belgium	38,049
,, France	71,512
,, Egypt	38,400
Other countries	247,620

Totals:—Cwts., 576,196; Nos., 6,290,385; value, 2,098,895*l.*

* Those marked with an asterisk are mainly imported into Liverpool or Bristol; the remainder mainly into London.

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HIDES: RAW, WET:—

	Numbers (approximate).
From Australia	162,734
„ British Possessions in South Africa	53,732
* „ United States of America	9,236
* „ Central America	11,866
* „ Brazil	143,834
* „ Uruguay	224,676
* „ Argentine Republic	82,304
„ Sweden	14,844
„ Denmark	16,484
„ Germany	394,477
„ Holland	245,325
„ Belgium	541,402
„ France	124,938
„ Portugal	36,090
„ Other countries	74,516

Totals:—Cwts., 614,471; Nos., 2,136,498; value, 1,645,786*l.*

SKINS: UNDRESSED, SHEEP:—

	Numbers (approximate).
From South Africa	2,242,713
„ Australasia	1,689,388
„ Argentine Republic	1,139,555
„ France	1,088,235
„ Turkey	491,085
„ Aden	318,585
„ East Indies	225,291
„ Uruguay	158,460
„ Germany	140,642
„ Belgium	109,075
„ Spain	99,275
„ Italy	98,830
„ Denmark	74,592
„ Brazil	72,993
„ Other countries	216,999

Totals:—8,165,718; value, 1,080,671*l.*

GOAT:—

	Numbers (approximate).
From British India, Bengal	1,187,853
„ Madras	425,527
„ Bombay and Scinde	28,603
„ South Africa	1,142,930
„ Aden	217,074
„ Turkey	120,553
„ Holland	74,165
„ France	63,481
„ Other countries	360,165

Totals:—3,620,868; value, 358,775*l.*

The number of rabbit-skins, kangaroo and other skins imported, amounts to over 20,000,000 annually. These come mainly from Australasia, and are discharged at the London Docks.

* Those marked with an asterisk are mainly imported into Liverpool or Bristol; the remainder mainly into London.

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The following table affords some indication of the extent to which the different ports of the United Kingdom share in this trade:—

Import of Raw Hides and Skins at Principal Ports (1882).

Ports.	Total United Kingdom.	London.	Liverpool.	Bristol.	Hull.	Southampton.	Grimsby.	Goole.	Harwich.	Newhaven.	Newcastle.	Other principal English ports.	Glasgow.	Leith.	Other principal Scotch Ports.	Dublin, Cork, and Belfast.	Other Irish Ports.
Raw Hides (cwts.)	1,190,667	666,763	203,208	78,869	77,805	39,855	5,434	3,433	3,556	2,907	1,950	1,686	7,175	4,567	2,240	3,415	—
Sheep Skins (numbers).	8,165,718	5,250,292	1,339,423	3,346	84,104	1,249,925	9,746	220	3,400	69,227	4,315	27,368	22,202	37,538	—	—	—

Goat skins (3,620,868) are principally imported into London.

In estimating the extent of the manipulation of foreign hides and skins in this country, a very large reduction must, however, be made from many of the above quantities; for much of the raw material is again exported to the Continent and America. Thus, during 1882, foreign hides were exported to the amount of 423,594 cwt.; sheep skins to the number of 801,389; and goat skins, 3,430,960.

NOTE B.

Histories of certain cases of Anthrax; Clinical Notes; and Notes on Autopsies.

[In the subjoined text a fuller record of a few of the more important cases included in the Table (page 122) is supplied.]

Case 7.—M. S., æt. 22, a tanner; admitted to Guy's Hospital under the care of Mr. Bryant on April 20th, 1882. Two days since (18th) found a pimple, that had for some time previously existed on neck, somewhat painful and slightly swelling. Now a pustule of typical appearance presented. 2 p.m., temp., 101°·6 F.; pustule excised. Midnight, swelling increased and extending over thorax.

21st. Patient distressed on account of difficulty of breathing; head and neck greatly swollen, so that he has to lie with head thrown back over a pillow. Temp. (noon) 101°·8. Incisions below angle of jaw to relieve breathing. Microscopical examination of serum and of blood gave negative results.

22nd. Temp. 100°·2. "No delirium, no sign of general sepsis. Death, apparently due to pressure upon air tube, at 2 p.m." P.M. examination refused.

Case 15.—A.B. (æt. 43), a sorter's labourer; admitted to Guy's Hospital on morning of February 20th, 1883, under the care of Mr. Davies-Colley. On Thursday evening February 15th, had noticed a small cherry-red "boil," about the size of a pea, on the seat of a scratch, near the mouth, he had received earlier in the day. Same evening, rigor; loss of appetite from that time; no rest; delirium at night. Redness, accompanied by puffiness, gradually increasing. Cough since Sunday, the 18th.

On admission: Patient, a well nourished muscular man; extremely weak; cannot stand. Near corner of mouth, a bright scarlet swelling, having a translucent appearance, with a depressed black centre. The swelling, which measures 1⅛ by nearly 1 inch, rises abruptly from the surrounding skin of

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the cheek, the latter being puffy but not perceptibly reddened. There are no distinct vesicles around eschar, but an herpetic eruption about the lower lip. The patient describes a gnawing sensation, not amounting to pain, in the pustule.

Temp. 99°·3. Pulse 80.

Pustule excised under chloroform; and the wound cauterized with Vacquelin's thermo-cautery.

Diet: brandy, beef tea, milk.

Serum obtained from vesicles showed abundant typical bacilli; "blood, only micrococci."

7.30 p.m., Patient feels better; t. 101°·1; 1 1.30 p.m., t. 98°·4.

21st. Fair night, t. (11.30 a.m.) 99·30°. Pulse, 72. Swelling of face subsided; complains of abdominal and lumbar pain.

22nd. Had a very restless night, and was slightly delirious; now, frontal headache and pain between shoulders. Has bad cough (little bronchitis) and breath smells very foul. Sputum contains bacilli and micrococci.

23rd. Wound red at edges. Urine examined microscopically showed presence of bacilli and micrococci. (Chicken added to above diet.)

26th. Wound dressed daily since last report; complains of slight frontal headache still. Had a good night. Slightly delirious at times. Temp., 97°. Pulse, 64. Cough better. Appetite good. Still some puffiness about angle of jaw.

27th. Fæces examined showed presence of bacilli and micrococci. Bacilli also found in the perspiration. (Ordinary diet ordered.)

March 1st. Slight frontal headache and cough. Temp., 96°; pulse, 66. Wound dressed daily.

2nd. Blood examined, no bacilli detected.

3rd. No cough; frontal headache continues. Temp., 97°·8; pulse, 57. To get up after tea.

6th. Patient feels better, t. 98°; pulse 75. (Full diet.)

10th. Pains between shoulders, not affected by respiration. Has had a feeling of faintness come over him, but has not lost consciousness. Perspires at times rather freely. Temp, 97°; pulse, 72. (Brandy, eggs.)

12th. Last night patient had an attack of diarrhœa. Ten motions, last containing a little blood and mucus. Eaten nothing but the ordinary full diet. Temp. (morning), 98°; pulse, 92. Fæces examined; no bacilli.

13th. Ordered to keep in bed, and put on light nutritious diet; milk, beef tea, eggs, farinaceous food; brandy. Fæces and sputum contain numberless bacilli.

14th. Fish diet.

16th. No diarrhœa since 13th. Wound nearly healed. Sputum examined, contains a few bacilli. Seems pretty well; ordered to get up.

17th. Full diet.

20th. Discharged. Urine examined and found to contain a few bacilli. Patient came twice to the hospital during next fortnight, complaining of ill-defined pains, muscular twitchings, cough, and debility.

Case 16.—W.S., æt. 33, sorter's labourer, admitted to Guy's Hospital under the care of Mr. Bryant, on Monday 26th February. On Thursday the 22nd, noticed pimple on left cheek. This, on Friday morning, was the size of a pea, and increased during day, swelling appearing under jaw. Began to feel unwell between 4 and 5 p.m. on Friday; appetite then impaired. This morning (26th) his hands got cold and dead, and he has suffered from retching and shivering.

On admission, at 11 a.m., on left cheek a raised sore: a central blackish slough, surrounded by a yellowish brown rim one-third of an inch broad, on which are the remains of vesicles now broken and exuding serum; surrounding swelling red, and with a translucent appearance. Glands under jaw much swollen; œdema extending round the neck as far as the spine, and in front as low as the clavicle.

Face, ears, and lips livid; hands slightly livid; complains of coldness of extremities; sensation in hands impaired; sweating profusely. Pulse, 132, weak; temp., 100°·2. Could not stand this morning.

Pustule excised at 3 p.m. by circular incision one-fourth of an inch outside vesicular ring; wound cauterized with benzine cautery.

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The administration of chloroform had been commenced, but patient struggled so violently, and became so extremely livid, that it was discontinued after about 30 seconds. Patient said the operation gave no pain.

Characteristic bacilli found in large numbers in serum from the sore and blood of wound; they were very numerous also in sputum, but none detected in blood drawn from finger.

Feeling of light-headedness and bad dreams; breathing oppressed. Taking iced milk and brandy.

Vomited several times; expiration "blowing" or "puffing," as though lips were paralysed. Died at 12 (midnight), having a sort of convulsion of the lower extremities.

Autopsy (by Dr. Mahomed) 12½ hours after death.—No signs of decomposition; rigor mortis well marked; much hypostasis, and body generally cyanosed. Wound of excision appeared healthy. *Head:* a few small patches of blood staining of pia-mater, especially over side of right hemisphere.

Respiratory organs.—Cervical glands vascular and somewhat swollen. No recent pleurisy. Lungs apparently healthy, but dotted here and there are dark red nodules, like small infarcts (about 20 in all). Neither inflammation nor œdema in surrounding tissue. Mucous membrane of trachea congested; bronchial glands not enlarged. Heart normal; aorta slightly blood stained. The blood unusually fluid and of dark colour.

Abdomen.—"Patches of injection could be seen through the *peritoneum* covering the small intestine, at the spots corresponding to the anthracoid nodules to be described. No lymph on peritoneal surface; but the peritoneum contains about two pints of dark yellow-red fluid. Mucous membrane of *stomach* thick and mammilated, with much adherent mucus. On the anterior wall, about middle of lesser curvature, is an oval patch, ¾ × ⅜ in., in the centre of which is a small dark slough, appearing to have already partly separated and the remainder being rapidly thrown off, leaving the muscular wall of the stomach exposed. Close by, a little nearer the pyloric orifice, is another small ulcer, about ⅜ in. by ⅛, from which the slough has entirely separated. These appear to be small anthrax nodules in course of natural cure. Passing down from the pyloric orifice the following condition was found pretty equally distributed throughout the small intestine:—In the *duodenum* and *jejunum* were numerous anthrax growths; in this part of the intestine they universally followed the line of the valvulæ conniventes; a portion of such a valve, varying in length from ¼ to 1½ inches, would appear with a black or rather dark-brown slough occupying the free edge of both surfaces, much like the brownish slough which occurs in the skin. Surrounding this would be an area of hyperæmia, with some swelling of the mucous membrane, varying in size according to the slough, but with a radius of not more than an inch in the largest."

"Lower down, where the valvulæ conniventes disappear or become less marked, the anthrax nodules became merely circular patches of raised blackish-brown slough with surrounding area of vascularity. In the lower part of the ileum the solitary glands were remarkably large and prominent, but there was no increased vascularity about them nor any slough in their centres."

"The cæcum was remarkably œdematous; its walls ⅜ to ½ inch thick, with pure œdema, no redness. It contained several anthrax nodules in its cavity, and around these were the usual vascular zones. They were also scattered through the upper part of the large intestine."

Mesenteric glands, not notably enlarged, but on section are seen to be vascular and of a purple colour. Some of them appear to contain small ecchymoses.

Spleen not much enlarged; but soft and diffluent.

Other abdominal viscera apparently healthy.

Case 34.—I. O. (aged 47) a tanner, admitted on September 4th, 1877, to Guy's Hospital, under the care of Mr. Howse. On August 21st, noticed a small pimple on cheek; on August 30th, cheek swollen. Patient thinks he has been poisoned in the tannery, and says it is not infrequent for men to be thus affected. On admission: chilliness; slight dyspnœa.

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Temp. 103° F.; pulse 101, rather weak. Vomiting on two previous days frequent. Patient complains of indistinctness of vision, of a burning sensation in legs, and of sleeplessness. Pustule excised and wound cauterized with a mixture of chloride of zinc and starch. *Sept.* 5. Weak and faint, had a little sleep, temp. 100°·4. *Sept.* 6. Feels better, œdema of cheek nearly disappeared. Bowels freely opened. Sharp pain in right side of neck. *Sept.* 7. Feels much better; takes his food well, does not have good nights. 10.30 p.m., vomiting, occasional cramps in limbs, and shivering. Sore over loins. Tem. 97°·9. *Sept.* 8, 1 a.m. Extremities cold, sweating. 10 a.m., pulse very weak; still pain over loins. Temp. 98°·0 F. Later, delirium. Death, 5 p.m.

Post-mortem examination, 45 hours after death: body cyanotic, especially the face, thighs, and scrotum; very fœtid smell. Tissues below wound of excision somewhat indurated, and one gland beneath jaw swollen and intensely congested. Otherwise no evidence of extension of the disease: veins and cellular tissue quite healthy. *Abdomen*: No general peritonitis, but over surface of small lengths of ileum were patches of very intense ecchymosis; here intestine remarkably thick and hard at its mesenteric attachment, but, with one exception, the corresponding mesenteric glands were not enlarged. The alimentary canal being laid open, in the stomach were found two or three raised flattened ridges of mucous membrane; firm to touch, and fleshy looking on section; their surface covered by a film of black discoloured blood. About the middle of ileum, at points corresponding with the ecchymoses on the peritoneal surface, were two large patches, about 3 inches in length, and separated by about 18 inches of healthy intestine, and beneath these again two smaller ones, where the mucous membrane was in a state of almost carbuncular inflammation. (To quote further Dr. Goodhart's notes: "There was no pus anywhere, though "it could not be doubted that the brawny swelling was inflammatory; "indeed I think that the term 'charbon of intestine' not a bad one; the "induration was very similar to that of the cheek.") The area of Peyers patches appeared least affected, and the solitary glands were not enlarged.

Lungs collapsed; spleen, pulpy; other organs, normal.

Notes on Autopsies (for clinical notes, see the table).

Case 37.—*E. M.* (aged 43). The starting-point of the disease was still marked as a purple patch, the size of a penny-piece, about one inch below the angle of jaw. The tissues beneath and for some distance around, including neck and upper part of chest, were infiltrated with inflammatory products. Nowhere was there any tendency to suppuration. The facial and jugular veins were healthy. The œdema extended probably along the planes of the cervical fascia, so as to reach the base of the tongue, the tonsular and faucical regions, all of which were extremely œdematous. The entrance of the larynx also immensely swollen, and the tissue in the ventricle of the larynx was likewise œdematous, bulging above the vocal cords. Lungs healthy.

Case 38.—*M. A. C.* (aged 11). Post-mortem, 26 hours after death. No sign of decomposition; much hypostasis. *External examination*: Several incisions near anterior part of neck, and below angle of jaw a vesicular swelling a line or two in diameter, with some raised thickening of its base. The skin and subcutaneous tissues around an inch and more in thickness from œdema. No suppuration anywhere. Cervical glands slightly enlarged. Pleuræ normal. Lungs normal, except that they contained an excess of dark blood. *Larynx*: Aryteno-epiglotidean folds considerably œdematous, not sufficiently so now as to close the rima, but flaccid and easily falling over the chink, and this had probably happened as the cause of death. *Intestine*: About 1½ inch above the cæcum a patch of intestine was covered by a flaky white membrane which rested on the surface of the mucous coat, but was not adherent to it. Neither was the mucous coat injected beneath it. Intestine elsewhere healthy. The *Vagina* at its upper part contained some pus-like fluid, and in scraping this away a velvety injected surface presented, which, on scraping, gave place again to smooth mucous membrane. The rugæ elsewhere injected, but not covered by any inflammatory product.

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NOTE B.—*continued.*

A TABLE of 37 CASES of ANTHRAX that have occurred in RECENT YEARS amongst
Cases observed amongst th

[NOTE.—Cases marked with an Asterisk were treated at Guy's Hospital; these, with the exceptio
contained in Vol. LXV. of the Medico-Chirurgi

No.	Physician or Surgeon.	Patient.	Sex.	Age.	Date of Attack.	No. of Days before applying for Medical Treatment.	Seat of Charbon.	Condition of adjacent Parts.
1	Mr. Dry -	J. D.-	M.	23	Feby. 10, 1882 -	5	Upper lip (typical lesion described).	Much swollen-
2	Mr. James -	G. N.	M.	24	Feby. 11, 1882 -	10	Chin (typical lesion described).	Neck much swolle
3	?	W. -	M.	18	Feby. 20 (about), 1882.	?	Forehead -	Swollen
4	Mr. Adcock	R. C.-	M.	21	March 3, 1882 -	4	Neck - -	Great swelling, ex tending down t breast.
5	Mr. Marshall	S. -	M.	52	March 4 (about), 1882.	9 (about)	Do. - -	Swollen and dark
6	?	C. B.-	M.	50	April 6, 1882 -	2	Under chin -	Glands on each sid swollen.
*7	Mr. Bryant	M. S.-	M.	22	April 17, 1882 -	3	Neck - -	Extensive œdema
8	London Hospital (out-patient).	F. D.-	M.	18	Feby. 1882- -	—	Under chin -	Swollen down to chest
*9	Mr. Golding-Bird.	G. P.-	M.	50	Feby. 1, 1882 -	1	Lower eyelid -	Slight œdema
*10	Mr. Howse -	J. J. -	M.	29	July 25, 1882 -	1	Neck - -	Diffused redness and œdema.

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NOTE B.—*continued.*

PERSONS ENGAGED in the LONDON HIDE and SKIN TRADE; to which are added two GENERAL POPULATION.

of two or three of the more recent, have before been recorded by Mr. Davies-Colley in a similar Table Society's Transactions.]

Constitutional Symptoms.	Where employed.	Occupation.	Apparent Source of Infection.	Treatment.	Result.	Remarks.
Headache only -	Messrs. Barrow's.	Tan yard labourer.	? Chinese hides (see text of report).	Poulticing -	Cured -	Confined to house two days, off work 17. Walked to surgery.
Headache and vomiting.	Do.	Do.	Do. -	Do. -	Do. -	In bed one week; then got up and walked to doctor's surgery. Off work a month.
None - -	Do.	Do.	Do. -	Do. -	Do. -	Patient went into the country. Manager of works describes typical pustule.
Extreme restlessness, cold sweats, difficulty of breathing; cyanosis. No delirium.	Do.	Tan yard labourer and fleaher.	Do. -	Do. -	Died (March 7).	Noticed pimple on Friday; restlessness, &c. first on Saturday night. Died Tuesday. Total abstainer. No p.m.
Pain and tightness in chest; vomiting, restlessness, alight delirium.	Do.	Tan yard labourer.	Do. -	Do. -	Died (March 17).	Constitutional symptoms (vomiting, pain) on Sunday 6.30 a.m. Died following Friday. Rapid decomposition. No p.m.
Headache only -	Do.	Do.	Do. -	Do. -	Cured -	In bed two days; off work five weeks.
Dyspnœa. T. 101°·6 F.	Do.	Tanner -	Do. -	Excision (without cauterization)	Swelling increased after operation. Death in 48 hours.	Fuller record in text (p. 118).
None - -	Messrs. Woods.	Carter -	Do. -	Cauterization	Cured -	Off work a week.
February 3rd. E. T. 102° F.	Messrs. Barrow's.	Tan yard labourer.	Do. -	Excision and cauterization	Cured -	Considerable inflammation and sloughing, which resulted in ectropion, followed operation.
(On admission) depressed, restless, faint, profuse sweats. T. 102°·4.	Butler's wharf.	Labourer.	Do. -	Do. (caustic potash)	Cured -	During convalescence pain in legs, with bluish-red patches; slight diarrhœa.

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No.	Physician or Surgeon.	Patient.	Sex.	Age.	Date of Attack.	No. of Days before applying for Medical Treatment.	Seat of Charbon.	Condition of adjacent Parts.
*11	Mr. Durham	T. E. -	M.	28	Aug. 8, 1882 -	8	Cheek - -	Face, neck, and cervical glands swollen.
12	Dr. Douglas	J. W.-	M.	30	December 10 (about), 1882.	6	Neck - -	Swollen - -
*13	Mr. Davies-Colley.	T. W.	M.	39	July 5, 1881 -	6	Cheek - -	Œdema to third rib
14	Mr. Marshall	R. N.	M.	18	Sept. 4 (about), 1881.	8	Under chin -	Much swollen -
*15	Mr. Davies-Colley.	A. B.-	M.	43	Feby. 15, 1883 -	5	Cheek - -	Puffy swelling; enlarged glands.
*16	Mr. Bryant	W. S.	M.	33	Feby. 22, 1883 -	4	Do. - -	Glands beneath jaw much enlarged; œdema down to clavicle.
*17	Mr. Howse	E. W.	M.	37	July 23, 1883 -	4	Do. - -	Swollen, red, and tense. Few enlarged sub-maxillary glands.
18	Dr. Gittins-	D. T.-	M.	44	Jan. 9, 1883 -	3	? Internal anthrax.	- - - -
*19	Mr. Lucas -	D. C.-	M.	18	Oct. 27, 1882 -	3	Neck - -	On admission, side of face and neck down to shoulders much swollen.
*20	Mr. Howse.-	G. B.	M.	31	Dec. 10, 1882 -	3	Do. - -	Swelling (not extending below level of thyroid cartilage). Few small glands rather hard.

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Constitutional Symptoms.	Where employed.	Occupation.	Apparent Source of Infection.	Treatment.	Result.	Remarks.
(Before admission) headache, shivering.	Butler's wharf.	Labourer -	? Chinese hides (see text of report).	Excision -	Cured -	The pustule developed at seat of old wound that had healed about six weeks before.
Headache, shivering.	Do.	Foreman -	Do. -	Poultices -	Do. -	Came to warehouse every day, but felt very ill. (Typical pustule described.)
Headache, loss of appetite. T. 101°. F.	Messrs. Barrow.	Tan yard labourer.	Do. -	Excision: and application of chloride of zinc.	Cured - (Rapid disappearance of local and constitutional symptoms after operation.)	Full account in Mr. Davies-Colley's paper. Bacilli not found in blood; found in the layers of the corium beneath eschar.
Headache, vomiting, restlessness; slight delirium.	Do.	Do.	Do. -	Poulticing -	Cured -	In bed three days, and only went to doctor on getting up. Off work eleven days; very weak for some time.
On admission, extremely weak; has had rigor; delirious at night; cough.	Do.	Do.	Do. -	Excision and cauterization.	Do. -	Bacilli found in all the excretions. Fuller account in text (page 118).
Shivering, itching, coldness and lividity of extremities. T. 100°·2. Sweating.	Messrs. Flack and Chandlers.	Sorter's labourer.	Do. -	Excision and cautery.	Died Feby. 26 (9 hours after operation).	Secondary affection of intestine, stomach, and lungs. Fuller account in text (page 119).
None - -	Do.	Do.	Do. -	Do. -	Cured -	Typical bacilli found in serum escaping from vesicles around eschar.
Profuse and fœtid perspirations, great restlessness, vomiting, dyspnœa, cyanosis; tetanic spasms.	Messrs. Anning and Cobb.	Do.	Do. -	- - -	Died Jany. 13.	Swelling of neck and chest, with much blue discolouration immediately after death. Fuller account, see text, page 112.
On admission, T. 102°·2. Oct. 31, drowsy, somewhat incoherent. T. 104°·6. Nov. 1, restless, more coherent. T. normal.	Gun and Shot Wharf.	Labourer -	Do. -	Excision and cauterization.	Cured -	Continued improvement after Nov. 1.
Shivering; headache. T. 101°·8.	A Thames wharf.	Do.	(Carrying dry hides.)	Excision; caustic potash.	Do. -	Continued improvement after operation. (I could not trace this man.—J. S.)

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No.	Physician or Surgeon.	Patient.	Sex.	Age.	Date of Attack.	No. of Days before applying for Medical Treatment.	Seat of Charbon.	Condition of adjacent Parts.
*21	Mr. Lucas -	B. M.	F.	14	May 1883 - -	6	Upper lip -	Swollen and brawny. Glands enlarged.
*22	Mr. Golding-Bird.	J. R.	M.	27	Sept. 16, 1881 -	3	Cheek - -	Swollen - -
*23	Mr. Jacobson	C. T.	M.	30	Aug. 25, 1881 -	2	Do. - -	- - - -
*24	Do. - -	F. F.	M.	47	June 29, 1881 -	4	Back of fore-arm.	- - - -
*25	Do. - -	F. R.	M.	31	April 9, 1881 -	7	Lower eyelid -	Upper eyelid and cheek swollen, abs. glands.
26	Mr. Francis Bonney.	J. W.	F.	67	March 10, 1881 (said he had been stung by a fly about 10 a.m.).	1	Neck - -	On 12th, dense swelling over throat and entire surface of cheek; 5 inches deep over sternum on evening of 12th.
*27	Mr. Lucas -	S. C.	F.	47	Dec. 25, 1881 -	11	Cheek - -	Eye closed; glands under jaw enlarged.
*28	Do. - -	D. W.	M.	23	Oct. 5, 1880 -	5	Do. - -	Much swelling. Eye closed; lip an inch thick; glands enlarged.
*29	Mr. Bryant -	J. R.	M.	28	Nov. 24, 1879 -	5	Forearm -	Blush, up to axilla
*30	Mr. Golding-Bird.	J. E.	M.	23	Nov. 9, 1878 -	4	Cheek - -	Swollen; glands enlarged.
*31	Mr. Howse -	F. H.	M.	18	Nov. 1, 1878 -	3	Chin - -	Much brawny infiltration.

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Constitutional Symptoms.	Where employed.	Occupation.	Apparent Source of Infection.	Treatment.	Result.	Remarks.
None - -	- -	"Unhairer"	English and Australian rabbit skins.	Excision; cautery.	Cured -	The centre of the pustule was black, but no secondary ring of vesicles. Blood and serum examined without discovering organisms.
No appetite; sick; limbs feel stiff.	Sun and Topping Wharf.	Sorter's labourer.	Bombay and Calcutta hides, horns, and hoofs.	Excision; galvanic cautery.	Do. -	——
Loss of appetite and sleeplessness.	Do. - -	Do. -	Bombay and Zanzibar hides.	Excision; chloride of zinc.	Do. -	——
None - -	A Thames wharf.	Stevedore	Loading Australian fleeces on 22nd June, again on 29th (latter, day of attack).	Excision -	Do. -	——
Sleeplessness; trembling.	Sun and Topping Wharf.	Labourer -	Australian fleeces; hides in warehouse where works.	Excision; chloride of zinc.	Do. (Rapid improvement after operation.)	Bacilli found in blood taken from wound. Full account of this case in Mr. Davies-Colley's paper.
Had to leave work evening of 10th (sick and giddy); 12th, p. 130; resp. 30. T. 104°. "Felt as if chest was filling up;" coma.	A Thames wharf.	Do. -	Hides; chiefly wet Russian.	Constitutional.	Died second night of illness (12th).	Mr. Bonney describes the pustule itself as "a hard carbuncular eminence, having a red pimple which shone, but apparently had no exudation."
Very little - -	Own home, Cubit Town	Household work.	Husband unloads ships, but had not been engaged on hides.	Excision; cautery.	Cured. (Rapid improvement after operation.)	Strict inquiry failed to show source of infection.
None on admission to hospital. Two days before had fainted twice, and had had a sleepless night.	Sun and Topping Wharf.	Labourer -	Sorting East India hides.	Do. - -	Cured -	The day he came to the hospital the swelling was subsiding.
None - -	- -	- -	Sheep and goat skins from Cape.	Excision; chloride of zinc.	Do. -	No bacilli found in blood or serum. (I did not trace this man.—J. S.)
Headache, shivering.	Tannery -	Labourer -	At "soaks" (first handling of hides).	Excision; carbolic and tannic acid.	Cured -	——
Looks quite healthy and strong.	Hide Wharf	Do. -	Foreign hides -	Excision; perchloride of iron and caustic potash applied.	Do. -	Nothing abnormal found in blood.

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No.	Physician or Surgeon.	Patient.	Sex.	Age.	Date of Attack.	No. of Days before applying for Medical Treatment.	Seat of Charbon.	Condition of adjacent Parts.
*32	Mr. C. Foster	A. P.	M.	17	Jan. 12, 1878 -	6	Anterior surface of forearm.	Glands enlarged
*33	Mr. Golding-Bird.	D. D.	M.	20	Oct. 14, 1877 -	3	Neck - -	Whole side of neck much swollen and brawny.
*34	Mr. Howse -	J. O.	M.	47	Aug. 20, 1877 -	15 after appearance of papule, 5 after swelling.	Cheek - -	Great swelling. Glands enlarged.
*35	Mr. Davies-Colley.	G. J.	M.	27	March 31, 1875 -	7	Do. - -	Some swelling of glands under jaw.
*36	Do. - -	J. F.	M.	33	Dec. 14, 1873 -	6	Chin - -	No surrounding œdema.
*37	Do. - -	E. M.	M.	43	Nov. 15, 1873 -	7	Neck - -	Hard œdema of neck.
*38	Dr. Habershon.	M.A.C.	F.	11	Oct. 13, 1873 -	6	Under chin -	Œdema of face and neck, glands swollen.
39	Dr. Jackson (Dr. Marshall and Sir Jas. Paget in consultation.)	Mr. G.	M.	—	March 29, 1873 -	1	Do. - -	On 30th March, slight swelling; on 31st, tissues in front of neck enormously swollen, hard and brawny, and discoloured.

A few other cases that did not, for one reason or another,

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Constitutional Symptoms.	Where employed.	Occupation.	Apparent Source of Infection.	Treatment.	Result.	Remarks.
Sick; faint; no rest; T. 101°·2.	Tannery -	Labourer (puts hides to soak.)	Foreign hides -	Excision -	Cured -	——
Temp. 103°; pulse 128. Day after operation, vomited, drowsy, restless, jerking movements of face and hands.	South-Eastern wharf.	Do. -	Five weeks ago unloaded dry hides; since then employed at same wharf, but chiefly in unloading potatoes and currants.	Do.; nitric acid.	Do. -	No bacilli found in blood. Patient for two days following admission continually expectorated "a clear, "thick, viscid "substance."
Vomiting; T. 103°, slight dyspnœa; great restlessness.	Sun and Topping Wharf.	Do. -	East Indian dry hides (Calcutta and Bombay).	Excision; (Sept. 4th), chloride of zinc.	Died, Sept. 8th.	Clinical and P.M. notes, page 120.
None - -	Wharf -	Do. -	Foreign hides -	Excision; chloride of zinc.	Cured -	——
None - -	Messrs. Anning and Cobb's warehouse.	Sorter's labourer.	East India hides -	Excision; chloride of zinc paste.	Do. -	For six years a total abstainer.
Dyspnœa, vomiting T. 100°·5.	Wharf -	Labourer -	Foreign hides -	Laryngotomy	Died, Nov. 24.	Two years total abstainer. P.M. notes, page 121.
Dyspnœa - -	- -	- - -	Not ascertained -	Incisions -	Died, Oct. 19.	P.M. notes, page 121.
On 30th March, feverishness; on 31st and following days, great and increasing difficulty of breathing and swallowing; profuse perspirations; foetid breath, delirium, prostration.	- -	Hide merchant.	? The handling of raw hides, or the sting of an insect on the river banks where the patient had driven.	Incisions and stimulants.	Death, Apr. 4.	When first seen by Dr. Jackson the swelling presented what appeared to be a minute central puncture.

admit of satisfactory investigation, were heard of.

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On the Occurrence of Anthrax in the London Hide and Skin Trades; by Mr. John Spear.

NOTE C.

[The subjoined Memorandum on the Clinical Characters of "Woolsorters' Disease" (Anthrax), was largely made use of during the present inquiry.]

The "Internal Form" of the Infection, or Anthrax Fever.

Premonitory Symptoms (of variable duration).—Chilliness, aching or stiffness of limbs, and mental depression. Restlessness, sense of constriction of chest, and oppression of breathing. Headache, dizziness, nausea, or, less frequently, vomiting.

Stage of Full Development.—Notwithstanding the indefinite premonitory symptoms, the stage of full development is generally somewhat sudden and unexpected in its onset, so as to cause much alarm. The prostration and restlessness become extreme; there are precordial anxiety and dyspnœa; blueness of the face and extremities (cyanosis) is conspicuous; and the patient may die within 24 or 36 hours with all the appearances of collapse or of asphyxia. A fatal termination is, however, more often postponed until from two to five days after the commencement of this stage. Other nervous phenomena—muscular paralyses, convulsions, or tetanic spasms—are then apt to develop themselves; and evidences of various acute local congestions (especially of the lungs, less frequently of the gastro-intestinal tract) are rarely wanting. Delirium is often absent; and the temperature is irregular. Exacerbations, alternating with more or less complete remissions, of the more urgent symptoms, constitute usually a striking feature of the disease. Recovery is not so rare as has been supposed, even in fully developed attacks; but death may occur from a relapse, or from secondary septic processes. The body after death usually undergoes rapid decomposition, with blue discoloration and swelling, especially about the neck.

[Before the disease was identified amongst the woolsorters, deaths were usually referred to one of the more prominent symptoms of anthrax, and registered as from "pneumonia," "enteritis," "peritonitis," "meningitis," &c.]

The "External Form" of the Infection, or Malignant Pustule.

The malignant pustule attacks almost always parts of the body habitually uncovered, and most frequently the face. It commences as a small papule, which quickly develops into a vesicle, and this, being broken, pours out a little watery exudation. The base of the vesicle, and the surface immediately adjacent, dies; so that in about three days after its appearance the lesion consists of a small central black eschar, with a raised border of inflamed and tumid skin upon which vesicles are apt to be developed; a crop of secondary vesicles surrounding thus the central eschar like a wreath. The neighbouring lymphatics and glands are speedily implicated; and the patient may soon lapse into the condition described above of constitutional infection.

The pustule does not apparently always present this typical appearance; when occurring upon the hands such appearance is uncommon. It has then no central black eschar, no raised vesiculated border. It is described as "a small, slightly inflamed tumor, exuding only serosity; "giving rise to comparatively little pain or even increased sensibility, "but showing a tendency to set up a diffuse cellulitis."* Constitutional infection may follow.

NOTE D.

Dr. Dupré's Analytical Report.

"I have carefully examined the various pieces of hides you left with me on July 7 with the following results:

"The Calcutta buffalo hide is cured with arsenic, but contains, comparatively speaking, but little of it.

* Report on "Woolsorters' Disease," in the Annual Report for 1880 of the Medical Officer of the Local Government Board.

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"The Calcutta cow hide is also cured with arsenic, and contains a considerable quantity.

"The hide from Patna district is cured by sulphate of magnesia, of which there is very much contained in it, with a trace of nitre and traces of calcium salts.

"The Bombay hide is cured by common salt. It contains no nitre.

"Both samples of China hide are cured by arsenic, and contain a very considerable quantity.

"I made some attempts to estimate the quantities of arsenic present, but in the first place the pieces of hide at my disposal were rather small, and in the second place, even in these small pieces, judging from the qualitative results, the quantity seemed so to vary in different parts that the estimate would not have been of much, if of any, use, or might even have been misleading."

Laboratory,
Westminster Hospital,
London, S.W.
August 7, 1883.

NOTE E.

Copy of Notice issued by Messrs. Dyster, Nalder, & Co., Hide Brokers.

Notice to Workmen engaged in handling Raw Hides, &c.

Occasionally a hide or skin that has been removed from the carcass of a diseased animal is improperly packed with others, and danger of infection to man may arise from handling it. The poison may be absorbed through the skin; or, as dust, through the lungs; or, with food, through the stomach.

When absorbed through the skin, a tiny boil or pimple, containing only watery matter, but soon accompanied by much swelling, is formed. The favourite seat of this pimple is the neck, face, or arms; if it be neglected constitutional mischief may follow.

When absorbed internally, constitutional symptoms afford the first indication. These, at the commencement, are not unlike the symptoms of a feverish cold, except that there is more marked weakness and depression; generally too the breathing becomes, from time to time, oppressed; sometimes there is vomiting.

Experience shows that the danger of these conditions is greatly aggravated by neglect in the early stages, and the following rules are accordingly suggested to the workmen:

1. Apply caustic freely to any small wound, scratch, or open pimple. (*caustic is kept for the purpose at the warehouse*).
2. Apply at once for medical advice on the appearance of a pimple such as is described above; or, on the occurrence of the constitutional symptoms, whether or not a pimple be present on the skin.

From the first suspicion of mischief, let the following precautions be observed:

3. Avoid exciting the circulation by unnecessary exertion, or especially by any over-indulgence in living. For food, take only a little beef-tea, broth, milk, eggs, or the like; if any stimulant be taken let it be only a very little spirit. Avoid, for the time being, beer, vegetables, and fruit.

The following regulations and advice are applicable to all men employed:

4. Needlessly rough handling of the hides, so as to cause an unnecessary amount of dust, is to be avoided. Coats, &c., are not to be hung in the warehouse rooms, and dust should be brushed from other clothes before leaving work. Food is not to be taken in the warehouse rooms, and the cleansing of the hands before meals is advised.

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App. A. No 14.

On Emigration and Immigration, &c.; by Dr. Blaxall.

No. 14.

ON the SANITARY ASPECTS of EMIGRATION and IMMIGRATION from and into the UNITED KINGDOM; and of the INTERCOMMUNICATION that takes place between the various HOME PORTS; by DR. F. H. BLAXALL.

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Cause of inquiry.

In consequence of the Local Government Board having received through the Foreign Office a despatch from Mr. Archibald, the British Consul-General of New York, on the subject of present extension of small-pox in the United States, stating that the belief was there entertained that it was largely contributed to by importation of the disease by immigrants arriving from this country and from the western parts of Europe, I was instructed by the Board to institute inquiry into the subject of emigration and immigration generally in its medical aspect, with reference specially to the risk of dissemination of infectious disease in our own country, and transmission thereof to other countries by means of ships clearing from our ports, as well as to any introduction of such disease into the United Kingdom from foreign countries. The inquiry was to include intermigrations by sea between the various ports of the United Kingdom, and to take cognisance of vaccination and re-vaccination as observed amongst emigrants and ships crews, small-pox being the disease specially referred to by the British Consul-General, who had forwarded, together with his despatch, an extract from the "New York Herald," containing the regulations adopted by the National Board of Health to the United States, requiring all unvaccinated emigrants, on arrival at the United States, to undergo "quarantine until they shall have "been properly vaccinated, or shall have passed the period of incubation "from date of last exposure;" together with a circular of the medical officer of health of New York requesting the shipping companies to take steps to secure the vaccination during the voyage of all persons requiring it.

Scope of inquiry.

Co-operation of the Board of Trade.

Upon the Local Government Board inviting the co-operation of the Board of Trade in the way of affording me information, and giving me introductions to their officers at the various ports, they at once suggested that their chief emigration officer, Captain Wilson, should be associated with me in the inquiry, and his practical knowledge of the Shipping and Passengers Acts and his acquaintance with the shipping companies have proved of great value to me.

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Increase and Development of Emigration.

British emigrants and "transmigrants."

The emigration of the United Kingdom consists of two elements, which may be called for brevity, British and Foreign; the former including natives of Great Britain and Ireland, the latter all other nationalities who may elect to come over from the Continent for the purpose of re-embarking from one or other of the British ports for the United States, British North America, or other places, and who may therefore conveniently be termed "transmigrants," consisting principally of Germans, Poles, Russian Jews, Norwegians, Swedes, Danes, Finlanders, and Icelanders.

Increase of emigration.

During the last 50 or 60 years emigration has greatly increased and developed, until it has attained a very important position amongst the various branches of commerce that contribute to the wealth and prosperity of the United Kingdom, and it now forms the subject of special legislation. This increase will be best understood by reference to the subjoined table of statistics abstracted from the Board of Trade returns, showing the number of emigrants that left our shores for certain specified countries in the six years 1815–1820 (the earliest period, that is, of which we have any such record) side by side with corresponding statistics for the six years 1876–1881.

Table 1.—Number of Emigrants that embarked from British Ports for certain specified Countries in the two hexades 1815–1820 and 1876–1881.

Period.	Destination.					Mean of the respective Periods 1815-20 and 1876-81.
	United States.	British North America.	Australasia.	All other Places.	Total.	
1815–1820	50,359	70,438	No return.	2,731	123,528	20,588
1876–1881	920,954	121,962	193,185	111,826	1,347,827	224,637

Comparing the two periods it will be seen that since 1820 emigration has increased more than tenfold. The numbers of emigrants during the six years 1876–1881 being 1,347,827, against 123,528 for the six years 1815–1820.

Since 1853 the emigration returns have been made out under the before noted headings, British and Foreign, the latter element entering into the returns for the six years 1876–1881 to the extent of 29 per cent. of the total emigrants; whereas probably it was almost if not altogether wanting in the earlier period, 1815–1820. Again, excluding the foreign element and taking the total emigration of the first period to represent British subjects only (which may fairly be done), it will be seen by the subjoined Table No. 2 that, calculated upon the population, British emigration during the six years 1876–1881 stands at 280 per 10,000 against 60 per 10,000 for the first hexade (1815–1820), an increase of more than fourfold.

Table No. 2.

Period.	Estimated average Population.	Number of British Emigrants.	Rate per 10,000 of Population.
1815–1820	20,581,419	123,528	60
1876–1881	33,958,708	952,384	280

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TABLE 3.—Showing the TOTAL AMOUNT of EMIGRATION from the UNITED KINGDOM, with the PLACES of DESTINATION, for the Eleven Years 1871–1881.

YEAR.	NUMBER OF EMIGRANTS.		TOTAL EMIGRANTS.	DESTINATION.				
	British.	Transmigrants or Foreigners.		United States.	British North America.	Australasia and New Zealand.	Cape and Natal.	All other Places.
1871	192,751	59,684	252,435	198,843	32,671	12,227	No return till 1877.	8,694
1872	210,494	84,719	295,213	233,747	32,205	15,876		13,385
1873	228,345	82,267	310,612	233,073	37,208	26,428		13,903
1874	197,272	43,742	241,014	148,161	25,450	53,958		13,445
1875	140,675	33,134	173,809	105,046	17,378	35,525		15,860
1876	109,469	28,753	138,222	75,533	12,337	33,191		17,171
1877	95,195	24,776	119,971	64,027	9,289	31,071	5,321	10,263
1878	112,902	34,761	147,663	81,557	13,836	37,214	4,930	10,126
1879	164,274	52,889	217,163	134,590	22,509	42,178	7,665	10,221
1880	227,542	104,752	332,294	257,274	29,340	25,438	9,803	10,439
1881	243,002	149,512	392,514	307,973	34,561	24,093	14,229	11,656
Total -	1,921,921	698,989	2,620,910	1,839,824	266,774	337,199	41,948	135,165

It will be seen by the above table that emigration is subject to considerable fluctuations, the total number of emigrants increasing from 252,435 in 1871 to 310,612 in 1873; then decreasing annually, till in 1877 it reached the minimum of 119,971, after which an annual increase is observed raising the total of 1881 to 392,514, a number which bids fair to be surpassed in the present year 1882, the returns for the six months, January to June, standing at a total of 245,031, against 211,113 for the corresponding period of 1881.

The rate of advance of emigration from 1877 to 1881 is shown to be more than twice as much amongst "transmigrants" than British emigrants, while the fluctuations in the annual tide of emigration affect mainly the United States, the number of emigrants arriving there in 1881 amounting to 307,973, against 64,027 in 1877.

Number of passengers to Australasia.

The highest number of emigrants for the Australasian Colonies was in 1874, amounting to 53,958, whereas other specified places exhibit a marked decrease in that year compared with the three preceding years. The statistics for the Cape and Natal are not given till 1877, when the number of emigrants is returned at 5,321, rising to 14,229 in 1881.

If the flow of emigration were steady and continuous throughout the year, 1,052 persons would have left our shores daily in 1881 for foreign countries; but so far from its being of this regular character, emigration has its busy and slack times; the months of April, May, and June being the season of its greatest activity. Not a little sanitary importance attaches to this circumstance.

Number of cabin and steerage passengers.

Another point to be considered in connexion with the health aspect of the question is the relative class of the passengers that embark from our ports; cabin passengers having distinct sleeping and living accommodation, and enjoying the advantage of a larger amount of cubic space than is allotted to steerage passengers.

The subjoined Table No. 4 is prepared to show the number of cabin and steerage passengers respectively, with the ports sailed from, in each of the six years 1876–1881, there being no record for previous years.

The comparatively large number of cabin passengers that start from Southampton is accounted for by this being the port of departure for the mail steamers to various parts of the world.

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Table No. 4.

Port of Departure.	1876.			1877.			1878.			1879.			1880.			1881.		
	Cabin.	Steerage.	Total.	Cabin.	Steerage.	Total.	Cabin.	Steerage.	Total.	Cabin.	Steerage.	Total.	Cabin.	Steerage.	Total.	Cabin.	Steerage.	Total.
Liverpool -	23,561	42,885	66,446	20,662	34,313	54,975	23,946	47,146	71,092	23,967	93,950	117,917	27,482	156,150	183,632	30,822	198,050	228,872
London - -	7,087	16,224	23,311	7,640	12,528	20,168	9,366	16,359	25,725	10,305	21,958	32,263	12,311	26,058	38,369	12,492	32,125	44,617
Glasgow and Greenock	2,588	10,179	12,767	2,166	7,841	10,007	2,596	11,389	13,985	2,214	18,317	20,531	2,750	26,340	29,090	2,787	39,349	42,136
Cork and Queenstown -	357	9,295	9,652	404	7,128	7,532	442	8,617	9,059	568	13,907	14,475	650	43,397	44,047	582	33,228	33,810
Plymouth & Dartmouth	261	11,945	12,206	524	15,331	15,855	622	14,767	15,389	888	14,966	15,854	881	9,465	10,346	1,147	10,066	11,213
Southampton - -	7,375	2,372	9,747	5,079	2,678	7,757	5,075	2,537	7,612	5,339	3,513	8,852	5,973	3,320	9,293	5,382	6,834	12,216
Other ports - -	671	3,422	4,093	672	3,005	3,677	1,121	3,680	4,801	647	6,624	7,271	737	16,830	17,567	1,058	18,592	19,650
Total - -	41,900	96,322	138,222	37,147	82,824	119,971	43,168	104,495	147,663	43,928	173,235	217,163	50,734	281,560	332,294	54,270	338,244	392,514

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Improved Facilities of Maritime Transport.

Improved facilities of maritime transport.

The increase and development of emigration until it had become an important branch of trade called for greater facility of transport. The old wooden sailing ships, which in their day did good service, were uncertain in their movements, being dependent upon the wind and currents, and, moreover, were of such limited capacity, carrying from 700 to 900 passengers only, that they were unequal to the requirements of a rapidly increasing traffic; hence, in process of time this class of vessel has had to give way to the magnificent steamers of the present day, which are to ocean traffic what railways are to land carriage in the way of economising time, and so reducing distance and bringing all parts of the world, as it were, closer together. For example, the voyage from London to Australia, which formerly occupied about 80 to 100 days, is now accomplished in 50 to 60 days; in like manner, that from Liverpool to New York is reduced from four or five weeks to ten or twelve days, and the same with regard to other places. The duration of any passage can be calculated with such nicety that the day of arrival at any specified port may be almost precisely determined. Together with these advantages may be considered the increased capacity and superior internal economy of the present ships, affording accommodation for some thousand to fifteen hundred or more passengers.

Commercial aspect.

In a commercial point of view the movements of such vast numbers of people as annually leave our shores is a matter of considerable importance, affecting, mainly and directly, shipping and railway interests, indirectly, shipbuilding, mechanics, and other branches of industry, besides giving employment to passage-brokers, emigrant runners, lodging-house keepers, and others; while, in connexion therewith, may be mentioned, as a matter of interest, the vast sums of money annually remitted by settlers in the United States and British North America to their friends in the United Kingdom, amounting in the 34 years 1848–81 to 25,016,463*l.*, exclusive of 336,196*l.* sent home from Australasia during the seven years 1875–81 (the first period for which any return of the kind is given).

On the other hand, increase of emigration may sometimes be taken as indicative of depression in industries at home, inducing the labouring population to seek employment in the Colonies or other countries where there is known demand for labour, there to remain until such time as, the condition of things improving at home, they are tempted to return, in this way swelling the emigration and immigration lists. I have observed examples of this notably among the miners of Cornwall.

Sanitary aspect.

The present inquiry, however, being concerned with the sanitary and not the commercial aspect of the question, the extent to which emigration is likely to endanger public health by introducing and spreading infectious disease, has now to be considered, and in order to the better understanding of the subject it is desirable to enter briefly into the nature and characteristics of diseases of this class.

Infectious Disease.

Certain dangerous diseases are capable of being spread by personal intercommunication between sick and healthy, or through the medium of infected clothing, bedding, and other channels. Of these diseases which are characterised as contagious or infectious, some appear to be indigenous to this country, such as small-pox, measles, scarlatina, diphtheria, typhus and enteric fevers, which are more or less usually present; others belong more exclusively to foreign countries, and the diseases of this group.

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such as yellow fever, plague, and cholera, do not appear in our own country till introduced from without. Yellow fever, though from time to time brought into our ports, has never gained a footing here, two or three outbreaks of small dimensions only having occurred. On the other hand, plague and cholera have now and again raged with fearful fatality. The plague indeed was endemic in this country in the seventeenth century, with occasional severe epidemic outbreaks: that known as the "Great Plague" occurring in 1665, when about 68,500 persons fell victims to it in the city of London and its suburbs alone. The last recorded death from plague in the metropolis was in 1679.

Cholera in more recent years has prevailed in England with fatal severity, notably in the years 1831 and 1848, and again in 1854, when upwards of 10,000 persons died of it in the metropolis alone. Dr. W. Farr estimates that little less than five millions of the people of the United Kingdom were attacked by cholera or diarrhœa in the epidemics of 1848–1849 and 1853–1854, and that a quarter of a million of those so attacked died. The last epidemic of cholera was in 1866; but occasional cases have since been witnessed in English ports from time to time.

These several diseases, while all in a greater or less degree contagious or infectious, possess distinctive characteristics which exercise important bearing on the danger and manner of spread.

(1.) *As to indigenous disease:—*

Means of spread.

Small-pox, measles, scarlatina, and typhus fever are mainly spread by means of personal contact with infected persons or infected articles of clothing, bedding, and the like, each new case offering a fresh centre of infection.

Small-pox possesses a very wide territorial range, establishing itself wherever introduced, and spreading rapidly and fatally; it is of all the above-named indigenous diseases the most highly contagious and fatal, proving a terrible scourge to the human race until the discovery by Jenner at the close of the eighteenth century of the prophylactic vaccination, which has robbed the disease of much of its danger and fatality.

Diphtheria is undoubtedly spread by infection from person to person, and possibly by other channels also, but the knowledge possessed on the subject is too limited at present to enable a definite opinion to be expressed.

Enteric fever so far differs from the above, in that the fever poison is usually spread through the agency of air or water that has become specifically contaminated by the bowel discharges of the sufferers.

(2.) *As to foreign diseases:—*

Yellow fever and plague are communicable from person to person; each disease showing some specialities of its own in the circumstances which influence its spread.

Cholera, like enteric fever, is mainly spread by means of specifically infected air or water.

Period of incubation.

In all infectious diseases a certain time elapses between the reception of the specific poison into the system and the manifestation of the symptoms, called the incubating period, and varying according to the nature of the disease. In small-pox, measles, typhus and enteric fever this latent stage is comparatively long, viz., from 10 to 14 or 15 days. In scarlatina it is shorter, being sometimes one or two days but usually

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varying from four to six days; and in diphtheria from two to four days. Yellow fever has a latent period of from one to 14 days. The plague is believed to have a largely variable incubating time, viz. from a few hours to 20 days, and cholera from two to 10 or 11 days.

Particulars of cholera.

My own experience as regards cholera, gained under circumstances favourable for observation, may be interesting. In 1850, while serving on board H.M.S. "Caledonia," 120 guns and 1,000 men, cholera broke out in the ship, which, together with the remainder of the fleet, was at anchor in Malta Harbour, the disease at the time being epidemic on shore, where it caused about 1,600 deaths. The first case in the fleet occurred on board the "Caledonia" on the 15th of June, four other cases occurred in that month, and the other ships were also invaded, in all some 40 or 50 cases occurred before the 3rd July, many of them proving fatal. On the 3rd July the ships went to sea. Fresh cases continued to occur in the "Caledonia" till the 8th, *i.e.*, five days after sailing, while in other of the ships fresh cases continued for 10 days; after this there was no fresh case, and the ships got absolutely free of cholera, continuing so for some two or three weeks. On the 30th July the "Caledonia" re-entered Malta Harbour, but left there again on the 1st of August, and on the 4th a fresh case of cholera appeared on board, followed by six others between the 4th and 14th, then no fresh case till the "Caledonia" for the second time went into Malta Harbour on the 2nd of September, remaining till the 4th. On that day a fresh case appeared followed by four others, but 10 days after this, the ship being at sea, cholera had disappeared. The men were medically inspected morning and evening, impending attacks were detected, and prompt measures of isolation and treatment were adopted.

Precisely similar behaviour of cholera was observed in the other ships.

Conditions favouring the spread of disease.

Without attempting to enter upon the question as to whether any of the foregoing diseases can arise de novo, it is a recognised fact that their presence is intimately associated with unwholesome conditions, such as impure air and water, overcrowding, insufficient ventilation, dirty dwellings, want of personal and general cleanliness, and the like, the causes themselves suggesting the line of remedy to adopt to keep such diseases in abeyance, while it may be gathered, from what is here stated with reference to the nature, characteristics, and manner of spread of infectious disorders, that much of the danger of their becoming widely diffused lies in the insidious way in which the infection is conveyed, it being quite possible for persons to contract disease by visiting infected persons or by unwitting exposure to infection in various ways, and yet not be made aware of the fact until some days afterwards, when the symptoms begin to develop, in the meantime going about mixing with others as usual. And even when the symptoms do manifest themselves, it often happens that, owing to the nature of the attack not being known, or from a reckless disregard to consequences, no steps are taken to prevent the further spread of the disease.

Danger to health.

Following up this argument we are led to recognise considerable danger as attending the movements of the vast body of emigrants that annually leave our shore for distant countries, rendering the adoption of precautionary measures to prevent the spread of disease through their agency a question not merely of national, but international importance.

In this country the paramount duty of providing for the protection and preservation of the health of the people has been recognised by the State, and various Acts of Parliament passed having for their object,

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amongst other things, the prevention of disease. And the efforts of the Legislature in this direction have been attended with practical good results, as anyone may satisfy himself who will study the Registrar-General's Death Returns for recent years and observe the changes in rate of mortality from all causes and particularly from those causes that are most amenable to public sanitary operations.

Statutory Enactments relating to Public Health, Shipping, and Passenger Traffic.

Laws affecting emigration and immigration directly or indirectly.

The various Acts passed by the Legislature with regard to vaccination, public health, and quarantine, and the Shipping and Passengers Acts have important bearing on the sanitary conditions of emigration, and in connexion with these may be mentioned the charter-parties of certain of the Colonial Governments for the conveyance of emigrants to their respective Colonies.

As to the Vaccination :—

Vaccination Acts.

The law renders infantile vaccination compulsory, requiring in England that every child shall be vaccinated before it is three months old, or at the next public vaccination held in the district after the child has attained that age.. In Scotland and Ireland the age is fixed at six months.

As a rule, the Acts are efficiently administered, and few children now escape vaccination.

Many foreign nations, also, have passed Acts rendering vaccination compulsory, but the ages adopted are higher than in the United Kingdom. For example, the German Imperial Vaccination Law of 1874 requires vaccination for all children before the end of their second year of life ; in Sweden the age is two years ; while in Holland there is no compulsory law, but a child is not admitted to a commercial school until it has been vaccinated.

In view of transmigrant families usually including infants and young children, the deferring of vaccination is a point not to be overlooked.

As to Public Health Administration generally :—

Public Health Act.

England, Scotland, and Ireland have distinct Public Health Acts, differing somewhat in detail, but the same in principle. The administration of these Acts is entrusted to local authorities exercising jurisdiction over certain defined areas, including in England port sanitary districts. The port sanitary authority is, in Ireland, styled port nuisance authority. In Scotland there are no constituted port sanitary authorities, but ships in any river, harbour, or other water are subject to the local authority of the district within or ex-adverso of which such river, harbour, or other water is situate. It will suffice here to refer to such sections only of the Public Health Act, 1875, (England,) as are more specially important with regard to emigrants, and deal with common lodging-houses, houses let in lodgings, nuisances, and infectious disease prevention.

Lodging-houses.

(*a.*) *Common lodging-houses.*—Every local authority is required to keep a register of all common lodging-houses within the district of such authority, and to "make byelaws (1) for fixing and from time "to time varying the number of lodgers who may be received into "a common lodging-house, and for the separation of the sexes therein ; "and (2) for promoting cleanliness and ventilation in such houses ; "and (3) for the giving of notices and the taking precautions in the

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"case of any infectious disease; and (4) generally for the well-ordering "of such houses."

Further, the keeper of a common lodging-house is required, when a person in such house is ill of fever or any infectious disease, to give immediate notice thereof to the medical officer of health of the local authority, and also to the poor law relieving officer of the union or parish in which the common lodging-house is situated.

(*b.*) *Houses let in lodgings.*—The Local Government Board may empower any local authority to make byelaws as to the cleansing, keeping, and regulating of "houses let in lodgings" in contradistinction to common lodging-houses.

Nuisances.

(*c.*) *Nuisances.*—Provision is made under this head, for enforcing the keeping of dwellings and their precincts free from "nuisances injurious to health," such nuisances being defined as including, amongst other things, over-crowding in dwellings, and foul privies.

The authority are required to cause to be made from time to time inspection of their district, with a view to ascertain what nuisances exist calling for remedial action. For the purposes of the Act relating to nuisances, a ship is considered as a dwelling-house, and it is part of the duty of port sanitary authorities to have inquiry made as to the sanitary condition of ships coming within their district, and to take the necessary steps to have any nuisances that may be discovered abated.

Disease prevention.

(*d.*) *Disease Prevention.*—Persons are made liable to penalties for the wilful exposure of infected persons or things; for neglecting to provide for the disinfection of public conveyances; for knowingly letting for hire any house, room, or part of a house in which any person has been suffering from dangerous infectious disease, without having such house, room, or part of a house, and all articles therein liable to retain infection, disinfected. Further, local authorities are required to secure the cleansing and disinfection of infected dwellings, and are empowered to direct the destruction of infected bedding, clothing, or other articles, and to give compensation for the same; they are also empowered to provide hospitals for the reception of cases of infectious disease ambulances for the conveyance of the sick, disinfecting apparatus and mortuaries, and to secure the removal to hospital of any persons suffering from dangerous infectious disorder who are without proper lodging or accommodation, or brought within their district by any ship or boat.

As to the Prevention of the Importation of Disease from Ship-board:—

(1.) *Quarantine.*—The provisions relating to quarantine (6 Geo. 4. c. 78., 35 & 36 Vict. c. 79. sched. V., re-enacting s. 52. of 29 & 30 Vict. c. 90., and 39 & 40 Vict. c. 36. s. 234), are administered by the Commissioners of Customs, under the Orders of Her Majesty in Council or of the Privy Council; the principal Order now in force being that of the 19th July 1825. Under this Order the masters of all ships coming foreign are bound, under penalty, to answer certain questions put to them by the officers of customs, as to the places from which they have come and as to the health of the crew and passengers. The other provisions of the Quarantine Acts, although susceptible of much wider application, have for some years been put in force only with regard to plague and yellow fever, and rather for the purpose of satisfying the exigencies of foreign nations, and preventing the inconvenience to trade which would

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result therefrom, than with the view of preventing the importation of those diseases.

(2.) *Medical Inspection*, under the orders of the Local Government Board, in regard to England; of the Privy Council, in regard to Scotland; and of the Lord Lieutenant, in regard to Ireland, with reference to diseases, such as cholera, not ordinarily present in the United Kingdom.

Under the provisions of the Public Health Act, 1875, relating to England, and under similar provisions of the Public Health Acts for Scotland and Ireland, regulations may be made for preventing the spread of cholera or any other endemic, epidemic, or infectious disease, and such regulations may apply to vessels within three miles of the coast. Orders issued in 1873 with regard to cholera, which are still in force, require the officer of customs on ascertaining or suspecting that a ship is infected with the disease to detain the ship, and inform the sanitary authority within whose jurisdiction the ship lies. The ship and the persons therein are then to be visited and examined by a medical officer; persons found to be suffering from the disease are to be removed to hospital, or if they cannot be removed, are to remain on board under the control of the medical officer; persons suffering from a disease suspected to be cholera may be detained for two days, in order to ascertain whether the suspicion is well founded. The bedding and clothing of persons who have suffered from the disease are to be disinfected or destroyed; and the ship, and other articles therein, so far as may be deemed necessary, is also to be disinfected.

The distinction, which should be noted, between this system and quarantine is that, in the latter, all ships which, according to the general rules laid down, were considered as likely to introduce disease were subjected, with their crews, passengers, and cargo, to certain prescribed measures of detention and disinfection; whereas in the former the circumstances of each particular case are to be the subject of examination, conducted by skilled officers, and each case is to be dealt with as this examination may show to be necessary.

A further distinction between the two systems should be had in view. Quarantine is administered by the officers of customs. The duty of carrying out medical inspection is imposed on the local sanitary authorities, including the special port authorities, of the places where a ship touches or ends its voyage. Although, however, this duty is imposed on the local sanitary authority, it is through the officers of customs, acting under the Quarantine Acts, and Order, that, in most cases, information is most generally obtained as to the existence of disease.

(3.) *Precautionary measures* for preventing the introduction of disease by ships, in the case of diseases ordinarily present in the United Kingdom, and as to which no special orders of the Local Government Board are in force.

The systems described in (1) and (2) of this section have reference to diseases such as plague and yellow fever (in the case of quarantine) and cholera (in the case of medical inspection), against which, as they are not constantly present in this country, extraordinary measures of precaution may reasonably be taken; but as cases of ordinary infectious disease are often present on board both of foreign-going ships, and of coasters, the local sanitary authorities have the necessary powers for dealing with ships coming within their jurisdiction, so as to prevent as far as possible the spread of disease from them. The removal to

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hospital of any person on board suffering from a dangerous infectious disease, and the disinfection of the ship, and of any articles therein requiring disinfection, as if the ship were an ordinary dwelling-house, can be enforced; and for the performance of these ordinary duties in regard to infectious diseases on shipboard, provision is made in the Board's orders as to the medical officers of health and inspectors of nuisances of port sanitary authorities for the examination of shipping and the periodical reporting thereon.

Shipping and Passengers Acts.

Health of Ships: The Merchant Shipping and Passengers Acts:—

Shipping Acts.

These Acts were passed by the Legislature in the years 1854, 1855, and subsequent Acts amending the same. The Shipping Acts are administered by the local marine boards under the supervision of the Board of Trade. These Acts make permissive provision for the medical inspection of crews before sailing; also, they require that each ship shall be supplied with medical stores, anti-scorbutics, lime-juice, vinegar, sugar, &c., the same to be duly examined by medical inspectors appointed by the Board of Trade or local marine board. Further, provision is made for the proper accommodation of the crew, regulating the superficial space to be allotted to each seaman, and requiring that due regard shall be paid to the construction, ventilation, light, and cleanliness of the portion of the ship set apart for their occupation, and that the same shall be kept clear of ship's lumber (ss. 224–231). Foreign-going ships carrying 100 persons or upwards are required to carry a duly qualified medical practitioner (s. 230).

Passengers Acts.

The Passengers Acts were formerly executed by the Emigration Commissioners, but the duties have since been transferred to the Board of Trade. They extend to every passenger ship proceeding on any voyage from the United Kingdom to any place out of Europe, and not being within the Mediterranean Sea, and to any ship bringing passengers into the United Kingdom. The expressions steerage passengers and emigrants are synonymous, and do not include cabin passengers.

The following abstract of certain clauses of the Passengers Acts will suffice to show the regard had to minute details concerning the arrangements of the ship, and other matters relating to the comfort and health of the passengers and crews.

Clearance of Ships.

It is enacted that no "passenger ship" shall clear out or proceed to sea until the master thereof shall have obtained from the emigration officer at the port of clearance a certificate that all the requirements of the Act, so far as the same can be complied with before the departure of such ship, have been duly complied with; and that the ship is seaworthy and fit for her intended voyage, and that her passengers and crew are in a fit state to proceed (s. 11).

That no ship shall carry under the poop or on the upper passenger decks a greater number of passengers than in the proportion of one statute adult to every 15 clear superficial feet of deck allotted to their use. And that no ship shall carry on her lower passenger deck a greater number of passengers than in the proportion of one statute adult to every 18 clear superficial feet of deck allotted to their use, where the height between such lower deck and the deck above it is 7 feet; but where the height between these decks is less than 7 feet, or the apertures (exclusive of side scuttles) through which light and air shall be admitted to the lower passenger deck less in size than in the proportion of 3 square feet to every 100 superficial feet of the lower passenger deck, no greater number of passengers shall be carried on such deck

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than in the proportion of one statute adult to every 25 clear superficial feet thereof (s. 14).

That there shall not be more than two tiers of berths on any one deck in any "passenger ship" allowing an interval of not less than 6 inches between the floor of the berths and the deck immediately beneath them, nor less than 2 feet 6 inches between each tier of berths and between the uppermost tier and the deck. No part of the berth to be within 9 inches of any watercloset erected in the between decks (s. 21). That single men of 14 years and upwards shall be berthed in a separate compartment. That not more than one passenger, unless husband and wife, or females or children under 12 years of age, shall occupy the same berth (s. 22).

Sleeping berths.

That in every passenger ship there shall be a sufficient space properly divided off to be used exclusively as a hospital or hospitals for the passengers: this space to be situated under the poop, or in the round house or in any deck-house, or on the upper passenger deck, and not elsewhere, and in no case to be less than 18 clear superficial feet for every 50 passengers. Such hospitals to be fitted with bed places, and supplied with proper beds, bedding, and utensils, and throughout the voyage kept so fitted (s. 24). That every "passenger ship" shall be duly ventilated and lighted to the satisfaction of the emigration officer at the port of clearance (s. 31).

Hospitals.

That no passenger ship shall proceed to sea with any cargo or ballast or other articles on board likely to endanger the health or lives of the passengers or the safety of the ship (s. 29).

Cargo endangering health.

That the provisions and water supply shall be sufficient in quantity and of good wholesome quality, and shall be issued regularly according to the dietary scale set forth in the Act (ss. 31–35).

Provisions and water supply.

That every passenger ship shall in the following cases carry a duly qualified medical practitioner: First, when the duration of the voyage exceeds 80 days in the case of sailing ships and 45 days in the case of steamships, and the number of passengers on board exceeds 50: Second, whenever the number of persons on board exceeds 300 (ss. 41, 42).

Medical practitioner to be carried.

That the owner or charterer of every passenger ship shall provide for the use and medical treatment of the passengers a supply of medicines, medical comforts, instruments, and other things, including a supply of disinfecting fluid or agent, &c., the same to be of good quality and sufficient in quantity for the probable exigencies of the voyage (s. 43).

Medicines and medical comforts, &c.

That no "passenger ship" shall proceed to sea until some medical practitioner, to be appointed by the emigration officer, shall have inspected such medicines, medical comforts, &c. &c. as are required by the preceding section, and also all the passengers and crew, and shall have certified that the medicines, &c. are of good quality, &c., and that the passengers and crew are in a fit state of health to proceed in the ship. Such medical inspection to take place either on board the vessel, or at the discretion of the emigration officer, at such convenient place on shore as he may appoint; the master or owner or charterer of the ship to pay to such emigration officer a sum at the rate of twenty shillings for every hundred persons so examined (s. 44).

Medical inspection.

Fees to be paid for medical inspection.

That the emigration officer at any port shall prohibit the embarkation of any person who by reason of sickness or other cause is unfit to proceed on the voyage, or is likely to endanger the health or safety of the other passengers, or if embarked shall require him to be relanded;

Persons suffering from infectious disease to be relanded.

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and if such emigration officer be satisfied that it is necessary for the purification of the ship that all or any of the passengers or persons on board should be relanded, he may require the same to be done (s. 45).

Passage money to be returned.

That any passengers so relanded on account of sickness who may not finally sail in such ship shall be entitled to recover the whole of their passage moneys (s. 46).

Sum allowed for subsistence of persons relanded.

That each passenger, reckoning as a statute adult relanded under s. 45 shall receive subsistence money at the rate of one shilling and sixpence per day until he shall be re-embarked or until his passage money, if recoverable under the preceding section, be returned to him (s. 47).

That in the case of any ship not sailing at the appointed time, every passenger entitled to a passage shall be paid subsistence money after the rate of one shilling and sixpence per day for each statute adult in respect of each day of delay for the first ten days, and afterwards three shillings per day until the final departure of such ship on her voyage (s. 49).

Regulations for preserving order cleanliness, &c.

Further Her Majesty is empowered by Orders in Council to prescribe rules for preserving order, promoting health, and securing cleanliness and ventilation on board of passenger ships.

Emigration prohibited during prevalence of certain epidemic diseases.

For prohibiting emigration from any port or ports at any time when choleraic or any epidemic disease may be generally prevalent in the United Kingdom or any part thereof, &c., and for requiring duly qualified medical practitioners to be carried in passenger ships, in cases where they would not be required to be carried under the provisions of this Act (s. 59).

Passage brokers.

As to passage brokers:—It is enacted amongst other things that no person whatever shall directly or indirectly act as a passage broker without a license (s. 66). Such license to be obtained by application to the justices at the petty sessions agreeably to the requirements set forth in s. 67.

Emigrant runners.

In like manner, as to emigrant runners:—That any person acting as an emigrant runner without having been previously duly licensed and registered shall be liable to a penalty for each such offence (s. 75).

Contract ticket.

Lastly, s. 71 provides for the issuing of contract tickets to cabin and other passengers. The contract ticket to be made out on a printed form in accordance with the form contained in Schedule K. for cabin passengers, and Schedule L. for all other passengers, and to be signed by the owner, charterer, or master of the ship.

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Schedule L.

Passenger's Contract Ticket.

These Directions, and the "Notices to Passengers" below, form Part of, and must appear on, each Contract Ticket.

1. A Contract Ticket in this Form must be given to every Passenger engaging a Passage from the United Kingdom to any Place out of Europe, and not being within the Mediterranean Sea.
2. The Victualling Scale for the Voyage must be printed in the Body of the Ticket.
3. All the Blanks must be correctly filled in, and the Ticket must be legibly signed with the Christian Names and Surname and Address in full of the Party issuing the same.
4. The Day of the Month on which the Passengers are to embark must be inserted in Words and not in Figures.
5. When once issued, this Ticket must not be withdrawn from the Passenger, nor any Alteration, Addition, or Erasure made in it.

Ship_____ of_____ Tons Register, to take in Passengers at_____ for_____ on the_____ Day of_____ 185_.

Names.	Ages.	Equal to Statute Adults.

I engage that the Person named in the Margin hereof shall be provided with a Steerage Passage to, and shall be landed at, the Port of_____ in_____ in the Ship_____ with not less than Ten Cubic Feet for Luggage for each Statute Adult, and shall be victualled during the Voyage and the Time of Detention at any Place before its Termination, according to the subjoined Scale, for the sum of £_____ including Government Dues before Embarkation, and Head Money, if any, at the Place of Landing, and every other Charge, except Freight for Excess of Luggage beyond the Quantity above specified, and I hereby acknowledge to have received the sum of £_____ in { full / part } Payment.

The following Quantities, at least, of Water and Provisions (to be issued daily) will be supplied by the Master of the Ship, as required by Law; viz., to each Statute Adult 3 Quarts of Water daily, exclusive of what is necessary for cooking the Articles required by the Passengers Act to be issued in a cooked State; and a Weekly Allowance of Provisions according to the following Scale:

[Here insert the Victualling Scale intended to be used on the Voyage. This must be either the Scale prescribed in the 35th Section of the Passengers Act, 1855, or that Scale modified by the Introduction of Articles authorised by the Act, to be substituted for Oatmeal, Rice, and Potatoes.]

[N.B.—If Mess Utensils and Bedding are to be provided by the Ship, the Stipulation must be inserted here.]

Signature in full_____

Place and Date_____

[If signed by a Broker or Agent, state on whose Behalf.]

Deposit £_____

Balance £_____ to be paid at_____

Total £_____

Notices to Passengers.

1. If Passengers, through no default of their own, are not received on board on the Day named in their Contract Tickets, or fail to obtain a Passage in the Ship, they should apply to the Government Emigration Officer at the Port, who will assist them in obtaining Redress under the Passengers Act.
2. Passengers should carefully keep this Part of their Contract Ticket till after the End of the Voyage.

N.B.—This Contract Ticket is exempt from Stamp Duty.

Ship_____

Counterpart of Passenger's Contract Ticket.

This Part of the Contract Ticket is to be separated from the other, and to be delivered by the Passenger to the Emigration Officer at the Port of Embarkation, (or, if no such Officer, to the Officer of Customs,) or to any one appointed by him to receive it, under a Penalty not exceeding £10.

Contract Ticket.

I engage that the Persons mentioned below shall be provided with a Steerage Passage to _____ and be landed at the Port of_____ in_____ in the Ship_____ of_____ Tons with not less than Ten Cubic Feet for Luggage for each Statute Adult, and shall be victualled during the whole Voyage according to the Dietary Scale prescribed by Law. The Ship to receive her Passengers at_____ on the_____ Day of_____ 185_. Passage Money, including Government Dues, if any, and all Charges of Landing £_____.

Names.	Ages.

_____ Souls, equal to * _____ Statute Adults.

To be signed in full by the Party issuing the Ticket. _____

* Insert Number of Souls and of Statute Adults respectively.

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Charter-parties.

As to the "charter-parties" of certain Colonial Governments :—

The Canadian, Cape, Natal, Tasmanian, and New Zealand Governments grant free or assisted passages to intending emigrants from the United Kingdom, making arrangements with certain of the shipping companies for their conveyance to the respective Colonies; while New South Wales, South Australia, and Queensland charter ships for this purpose. (The Colony of Victoria has not granted any passage to emigrants since 1873.)

The conditions of the several "charter-parties" are very precise, stipulating, amongst other provisions, that the ship shall be fitted with sufficient scuttles, deck lights, and ventilation; also with proper bed places, seats, tables, waterclosets, hospitals, baths, &c., &c. That the between decks shall be divided into three compartments only, viz., for single men, married couples, and single women, and that there shall be at least one separate hatchway and ladderway from each compartment to the upper deck. That the provisions and water shall be of the best quality and of sufficient quantity and shall be issued during the voyage agreeably to a fixed scale, also that a cabin properly fitted up shall be provided for the surgeon superintendent, who is appointed by each Colonial Government and entrusted with the care of the emigrants during the voyage, special instructions being issued for his guidance (which will be herein-after referred to at length). New South Wales "charter-party" provides for three hospitals, viz., one each for single women, married women and children, and men, to be placed on the upper deck when practicable. Queensland "charter-party" prohibits any hospital being situated between decks.

PART II.

Emigration Practice on Shore and on Shipboard.

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Intending emigrants (initiatory proceedings).

The several shipping companies keep the subject of emigration before the eyes of the public by advertisement in the newspapers and placards posted up in frequented places, instructing intending emigrants to apply for detailed information to their various agents established throughout the United Kingdom, who are authorised on payment of a deposit to enter into contract with them in accordance with the terms set forth in the "contract ticket" prescribed by the Passengers Act, a copy of which is given to the intending emigrant to be retained by him to the

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end of the voyage, while the counterpart thereof is to be delivered up to the emigration officer at the port of embarkation. Emigrants are instructed to attend at the company's offices either on the morning of embarkation or on the previous day, to pay the remainder of the passage money, and so complete the contract.

Transmigrants.

A similar course is pursued with regard to transmigrants; these negotiate with the company's agent for passage to the United States or elsewhere, as the case may be, the contract to include transit to the United Kingdom, thence by rail to port of embarkation, subject to detention there, pending the sailing of the ocean steamer, when they are lodged and boarded at the company's expense.

Colonial emigrants.

The Agents-General of the several Colonial Governments have established agents in various parts of the United Kingdom, who are empowered to furnish particulars to intending emigrants applying for free or assisted passages to the Colonies. But before these can be granted the applicants are required to satisfy the Agents-General as to their state of health, their character, capabilities as workmen, &c.

Emigration port visited.

In order to make myself thoroughly acquainted with the sanitary circumstances connected with this subject, I visited, in company with Captain Wilson, the principal emigration ports of the United Kingdom, namely, London, Liverpool, Plymouth, Glasgow, Greenock, Leith, and Queenstown, with ports of less note, interviewing the representatives of the various shipping companies, and inspecting the emigrant lodging-houses, infectious hospitals, and many of the passenger ships, witnessing the embarkation of emigrants.

Shipping companies.

The principal shipping companies engaged in the emigration traffic, and the ports from which their ships sail, are as follows:—

The Monarch, National, Orient, Castle, Union, and Royal Indian sail from London to all parts of the world, certain ships calling at Southampton, Dartmouth, and Plymouth to pick up passengers.

The Cunard, White Star, Indian, National, Guion, American, Dominion, Beaver, and Lake Line sail from Liverpool mainly to the United States and British North America, calling at Queenstown.

The Anchor, State, and Allen Line from Glasgow and Greenock for all parts, calling at Londonderry and Belfast.

The subjoined Table No. 5 is prepared to show the relative importance in the passenger traffic of the principal emigration ports for a period of eleven years, 1871-81.

It will be seen that in eight years out of the eleven a larger number of emigrants embarked from Liverpool than from all the other ports put together, and that for the whole period the total emigration from Liverpool was 1,486,538, against 1,134,372 from all other ports, an excess of 351,166 emigrants.

Continental ports.

The principal continental ports are Hamburgh, Christiana, Gottenburgh, Copenhagen, and Bremenhaven, whence passengers are brought mainly to Hull, a fewer number to London, Leith, and Granton, and still fewer to Newcastle and Sunderland.

Continental steamers.

The continental steamers engaged in this traffic are:—The Wilson Line that bring passengers from Hamburgh, Copenhagen, and Gottenburgh to Hull.

The Bremen Line, from Hamburgh to London.

The Currie Line, from Hamburgh, Copenhagen, and Bremenhaven, to Leith or Granton.

The Slimon Line, from Iceland to Leith or Granton.

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Table No. 5.—Number of Emigrants (British and Foreign) embarked from specified Ports of the United Kingdom for Places out of Europe, and not within the Mediterranean Sea, in each of the eleven years 1871–81.

Ports of Departure.	Number of Emigrants that Sailed in each of the 11 Years.											
	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	Total.
Liverpool - - - -	166,166	195,776	190,157	122,015	89,540	66,446	54,975	71,092	117,917	183,582	228,872	1,486,538
Other Ports—												
London - - - -	14,618	22,002	26,682	44,853	26,779	23,311	20,168	25,725	32,263	38,369	44,617	319,387
Glasgow and Greenock - -	23,039	23,192	24,526	19,766	15,109	12,767	10,007	13,985	20,531	29,090	42,136	234,148
Cork and Queenstown - -	30,660	33,616	40,314	28,011	17,374	9,652	7,532	9,059	14,475	44,047	33,810	268,550
Plymouth and Dartmouth -	3,614	3,527	5,136	7,664	8,104	12,206	15,855	15,389	15,854	10,346	11,213	108,908
Southampton - - -	3,399	4,411	7,904	8,549	10,348	9,747	7,757	7,612	8,852	9,293	12,216	90,088
Londonderry - - -	9,607	10,512	11,311	6,419	4,112	2,614	2,373	2,905	4,600	10,965	9,811	75,229
Other Ports - - -	1,332	2,177	4,582	3,737	2,443	1,479	1,304	1,896	2,671	6,602	9,839	38,062
Total - - - -	86,269	99,437	120,455	118,999	84,269	71,776	64,996	76,571	99,246	148,712	163,642	1,134,372

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The steamers vary in size, one of the largest of them, the "Romeo" (Wilson Line), carrying from 500 to 600 adults, and the "Capella" (Bremen Line) about 80 passengers. They do not come under the Passengers Act, but are subject to the Mercantile Shipping Act, and as a rule, do not carry a surgeon, but the Allen Company usually send one to take medical charge of the transmigrants from Iceland to Granton.

Wilson Line.

Some short time since the quality and amount of accommodation afforded by these vessels engaged the attention of the Board of Trade, when they instructed Captain Wilson, their chief emigration officer, to inform himself upon the subject and report accordingly. For this purpose he made two voyages in the Wilson boats, the first in the steamer "Angelo" from Christiana to Hull in September 1881, a slack period when few emigrants were on board; the second in the "Romeo" from Gottenburgh to Hull in May 1882, the busy season when the ship was crowded. Thus we have the advantage of Captain Wilson's observations in the continental traffic arrangements, as viewed under different conditions.

To summarise the statements in his report:—

In the "Angelo" the emigrants were berthed in two compartments. The after compartment was 47 feet long by 28 feet mean breadth. The sleeping accommodation consisted of two shelves 5 feet 8 inches wide on each side of the vessel running the entire length of the compartment, with no sub-divisions of any kind denoting the berthing-space of each emigrant. The lower shelf was 15 inches above the deck, the interval between the shelves 32 inches; and the upper shelf 42 inches from the deck overhead. The compartment was well ventilated and amply lighted by the hatchway (8 feet square) and by two cowl ventilators, one in the fore part and the other in the after extremity. The deck was of iron, and the ladders not lined at the back. The forward compartment was 60 feet long, and the fittings substantially the same as those above described, but the deck was of wood.

There was no attempt at the separation of the sexes, nor any curtains to screen the sleeping arrangements from the central portion of the deck.

The closet arrangements were bad, the closets being small, cramped, dark, and unprovided with water for flushing. Those for males and females close together, and the entrance to them in no way protected from the weather. Altogether (Captain Wilson states) "more evil-smelling, unsatisfactory places it is difficult to imagine."

The provisions and water supply were ample and of good quality.

Captain Wilson suggested that the iron decks should be sheathed with wood, and the deck ladders lined at the back; that the closets should be provided with a constant supply of running water, that those for men and women should be on opposite sides of the vessel, and that the women's closet should either be under the deck or entered from below; that the floors of closets should be cemented, with grooves cut in the cement for carrying off any wet, &c.; that the sexes should be sub-divided to the extent of separating the single men.

On the occasion of Captain Wilson's second trip in the "Romeo" he again inspected the "Angelo," when, it is satisfactory to report, he found the evils he had pointed out remedied, the owners having carried into effect the measures of improvement he had suggested to them.

With regard to the "Romeo;" the emigration season was at its height, the emigrants from Gottenburgh alone amounting to some 2,000 or so weekly, necessitating the putting on of extra boats. The decks of the "Romeo" were of wood; she contained three compartments for emigrants; they were well ventilated and duly lighted; two of them were

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fitted up with sleeping berths in two tiers with movable partitions about 8 inches high separating the space allotted to each individual, the remaining compartment was set apart for single women. The sleeping-berths consisted of long shelves with no partition boards. The water-closet arrangements were satisfactory, the closets for men and women being on opposite sides of the ship. The vessel was crowded, but not more so than admissible by the Board of Trade regulations. Captain Wilson saw reason, however, to recommend an increase of space, viz., from 72 to 100 cubic feet, especially to passengers on the lower deck.

The supplementary boats were reported as unsatisfactory in respect of accommodation, but the owners at once adopted the measures Captain Wilson recommended, and expressed general desire to do what might conduce to the comfort of the emigrants.

Bremen Line.

I am indebted to the same source for the following information respecting the "Capella" and "Vega," two of the Bremen Line that run between Hamburgh and London, the passage occupying about 44 hours. The passengers by this line are mostly Germans. "In "the 'Capella' the emigrants are berthed in the alley-ways under "the bridge deck," and "in the 'Vega' in the foremost end of a "long poop, in the passage-way round the engine-room hatchway, "and houses, galley, and amidships in continuation thereof. "The "sleeping accommodation consists of two shelves 7 feet wide, the lower "about a foot from the deck, with an interval of 3 feet between the "shelves; there is just sufficient room to sit up on the shelves." "The "'Vega' can be fitted for 160 in the season, and has carried 220. "When more than 160 are on board, accommodation for the extra "numbers is provided on the same principle in the lower 'tween "decks."

The closet arrangements appear to be insufficient for the numbers of passengers carried. The "Vega" has only two closets, situated at the after end of the forecastle, and unsupplied with water. Captain Wilson considers the vessel should have at least six. The "Capella" has only one closet, and no water in it, for 80 passengers.

Currie Line.

Mr. Murray, principal officer of the Board of Trade at Leith, informs me that the passage from Hamburgh and Bremenhaven to Leith each occupies about 48 hours, and that from Copenhagen to Leith 72 hours. The accommodation allotted to emigrants between decks is ventilated by the hatchways and cowl ventilators, and lighted by bulls-eyes and the companion way; temporary berths are fitted up in a sufficiently comfortable manner. An attempt was made to separate the sexes, but it was found not to answer, the emigrants preferring to travel in families. Separate closet accommodation is provided for men and women.

Iceland steamers.

The Slimon steamer "Camoens" brings passengers from Iceland to Granton, the passage occupying usually about four days, but sometimes extending to 10 days when ice is encountered. The compartments are lighted and ventilated by hatchways, cowl ventilators, and a few side scuttles, which can be opened in moderate weather. A separate compartment is reserved for single men. The closet accommodation consists of five waterclosets. Sometimes these boats have from 700 to 800 transmigrants on board. They find their own provisions, but should the passage be protracted, I am informed that there is no fear of their being hard up for food, as there is always a good stock of ship's provisions to fall back upon.

With regard to the amount of accommodation afforded by the continental steamers, there can be no doubt that at times there is much crowding in them, an evil which probably is very difficult to guard

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against considering the immense flow of emigration in the months of April, May, and June; but the fact of the passages being of short duration minimises the evil.

On the other hand, the inadequate amount of closet provision and the absence of water for flushing purposes, specially as regards the Bremen Line, indicates the want of closer supervision to insure these vessels being kept in a proper sanitary condition.

Transmigrants, debarkation of.

Upon arrival of the continental steamers at the port of London the transmigrants are met by the agents of the respective shipping companies, who conduct them to the lodging-houses, where they remain till the sailing of the ocean steamers.

At Hull, Leith, and Granton the arrangements are somewhat different, as the transmigrants do not re-embark from these ports.

Hull.

I did not myself visit the port of Hull, but I gather the following particulars from the reports of my colleague, Dr. Airy, and Messrs. Grey and Cowie, of the Board of Trade.

The departure of a steamer with transmigrants from the foreign port is telegraphed to Hull, together with the number of passengers she carries, to enable the agents to make arrangements for their conveyance by railway to Liverpool or other port, and to have refreshment ready for them to partake of before starting.

The steamers usually arrive on the Sunday, when some of the male passengers land and stroll about the town, but all sleep on board that night.

On the following morning the process of debarkation commences, and is carried out under considerable discomfort and much confusion; the landing of passengers and baggage, the discharge of cargo, and preparations for re-loading the vessel all going on at the same time, and no efficient accommodation provided for the shelter of the passengers.

The agents meet the transmigrants at the dock, sort their baggage, and conduct them to the lodging-houses, where a déjeûner is already prepared for them. They then proceed to the railway station whence they are despatched to Liverpool or other port; a special train being provided for them when their number reaches a hundred or so, otherwise they travel by the usual passenger train.

On arrival at their destination they are conducted by the agents of the company to their respective lodgings.

Leith and Granton.

The ports of Leith and Granton offer facilities for the disembarkation of transmigrants, possessing each a good pier with a railway station close at hand. On arrival of the vessels in the Frith of Forth the agents make arrangements with the railway companies for the conveyance of the transmigrants to Glasgow or Liverpool, as the case may be, the bulk of them remaining on board till the train is ready for them, when they are landed on the pier, and at once proceed on their journey.

British emigrants.

With regard to British emigrants, it is presumable that they would, as a rule, elect to sail from the port nearest their own homes, but this would in most cases necessitate arrival there the day prior to embarkation. Unlike transmigrants, however, their movements from the time they leave their homes to the date of sailing are quite of an independent character; I was, therefore, unable to obtain any information respecting them beyond the fact that the companies' agents are not instructed to commend them to any particular lodgings. Thus they are free to find their way to one or other of the various lodging-houses with which the ports abound, or if they chance to have friends in the neighbourhood they would probably stay with them pending the sailing of the ocean steamer.

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App. A. No. 14.

On Emigration and Immigration, &c.; by Dr. Blaxall.

Lodging-House Accommodation and Infectious Hospital Provision at the several Ports of Embarkation.

Lodging-houses. (General observations).

It may be premised that, as a general rule, the principal shipping companies contract with certain lodging-house proprietors to board and lodge the transmigrants at the rate of 1*s.* 6*d.* per day for each statute adult. Thus the lodging-houses are to a certain extent under the control of the shipping companies who exercise supervision over them, and direct members of their staff to visit them frequently when in occupation, to insure the transmigrants being properly accommodated and well cared for.

Should the number exceed the amount of accommodation the lodging-house proprietor has at command he farms them out.

In our inspection of the lodging-houses we visited them under various circumstances, and at different times, both when full and the emigrants at their meals, when just vacated, and when for some days they had been unoccupied. Taking them altogether they were well ordered and in satisfactory condition, being clean, well ventilated, and light. When exceptions were found in these respects the same will be specially mentioned.

In all cases the provisions, consisting usually of soup, bread, meat, potatoes, and other vegetables, were of good quality, well cooked, and comfortably served up.

I propose now to take the ports seriatim:—

London. (Lodging-houses.)

(1.) London (*Lodging-Houses*). For health purposes the Metropolis is subdivided into various sanitary districts. The emigrant lodging-houses are mostly situated in the City, Whitechapel, and St. George's-in-the-East districts, and are under the jurisdiction of the respective sanitary authorities. The principal part of the emigrant lodging-house business is in the hands of two proprietors, with whom certain of the shipping companies are in direct relation. One has a large hotel in the Crescent, Minories, City, and the other a lodging-house on Tower Hill. Besides these, there are other lodging-houses which are let to transmigrants independently of the shipping companies. All, with one exception (Victoria House), are unregistered. At the time of my visit the hotel in America Square was full of transmigrants who were having their dinner, and everything appeared to be in good order. The house on Tower Hill was empty of lodgers. Here I observed a watercloset situated in the centre of the dwelling with no communication with the external air,—an unwholesome condition affording means of entrance of sewer air into the dwelling. A house in Mansell Street, under orders of the police to be registered, was full of Polish Jews, proverbial for their dirty habits, but independently of this the general condition of the house betokened a want of cleanliness and an absence of proper supervision. The walls of the rooms were dirty and there was an accumulation of flue under the beds, while the closets, situated in the yard, were in a neglected state and had no water for flushing purposes. The inspector of nuisances of the Whitechapel district accompanied me to several lodging-houses in crowded localities, but we found them closed. The inspector told me that proceedings had been threatened against the proprietors of these houses on account of bad drainage, unwholesome closets situated in the house, indecent occupation, and overcrowding. In one instance five adults were found sleeping in one room with a cubic capacity of 840 feet or 168 cubic feet per individual. The inspector of nuisances added that the houses frequently changing hands militated against getting improvements effected.

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With regard to Victoria House, above mentioned as registered, it is situated in Upper East Smithfield, near the docks, and contains 150 beds, so arranged as to secure privacy together with ventilation and light. It is provided with lavatories and good cooking arrangements, commensurate with the requirements of the establishment. The weak points observed were waste pipes in the washhouse and scullery in direct communication with the sewer, reliance being placed on double traps to prevent the escape of the foul air of the sewer into the dwelling. The waterclosets were situated on the basement and had no opening to the external air.

Infectious hospitals.

Infectious hospital provision is always ready at command, and cases of infectious disease occurring amongst transmigrants whilst staying at lodgings on shore are taken to one or another of the establishments.

In 1872, when an invasion of cholera was apprehended, the port sanitary authority provided a floating hospital, the "Rhin," which is anchored off Gravesend, and in more recent years has come to be used for cases of other infectious disease, including cases detected amongst emigrants on the point of embarkation.

Liverpool.

(2.) LIVERPOOL. Taking the 11 years 1871–1881, as shown on table, page 148, the lowest number of emigrants embarked in one year was 54,975 in 1877, the highest number, 228,872, in 1881; thus showing the extensive and varying demand on lodging-houses at this port.

Lodging-houses.

The lodging-houses are duly registered and regulated by byelaws in accordance with the requirements of the Public Health Act, 1875, and are subject to efficient supervision under the sanitary authority, where, if overcrowding or other irregularity contravening the law be detected, proceedings are taken against the proprietors. Dr. Taylor, the medical officer of health, informs me that 300 cubic feet is given as the standard amount of cubic space to be allotted to each statute adult, but in new houses he is trying to get this increased to 350 or 400 cubic feet. The smallest of the houses visited had accommodation for 50 persons, the largest in occupation for 300, besides which an old hospital recently taken by one of the lodging-house proprietors has been fitted up for the reception of emigrants, and is capable of accommodating 500. Altogether the houses inspected were in a very satisfactory condition, but one or two matters of detail may be mentioned as calling for improvement. Thus, in one house the sleeping bunks were arranged in two tiers, one above the other, which Dr. Taylor, recognising as a bad plan, is endeavouring to get remedied. In a second house I observed an ill-ventilated watercloset, and on the premises of a third and fourth house a cesspit and a filthy privy. These are evils which may safely be left in the hands of the authority to rectify.

The infectious hospital provision consists of—

Infectious hospital.

(*a.*) The workhouse hospital. It is to this hospital that emigrants are by leave of the guardians mostly sent, the sanitary authority not possessing a hospital. The building is on a large scale to meet the requirements of the city, which are considerable, a large number of the working-class, earning only just sufficient for their daily wants. Thus, when overtaken by sickness they have no means of supporting themselves and apply to the parochial institution for assistance.

(*b.*) The Netherfield Hospital, established and partly maintained by voluntary contributions, the sanitary authority paying largely towards it. The accommodation consists of seven single-bedded rooms and ten wards with 80 beds.

(*c.*) An iron hospital, erected by the port sanitary authority in anticipation of a visitation of cholera; it occupies an open plot of ground at

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New Ferry, on the Birkenhead side of the river, remote from dwellings and convenient for the water, enabling cases to be landed on its precincts. Happily, cholera has not appeared, but the hospital has been used in one instance, namely, when given up for the reception of cases of scarlatina occurring amongst the boys belonging to the training ship.

Plymouth. (Depôt.)

(3.) Plymouth. Emigrants from this port are chiefly sent out by the agents of the Australasian Governments, who have arrangements with the proprietor of a large depôt at Plymouth for their being received and lodged there pending embarkation. The site of the depôt has much to recommend it, standing on the west shore of Deadman's Bay, having the water of the harbour on the east and south side, the citadel on the west, and the Commercial Wharf on the north. There is a good yard for the emigrants to walk about in, overlooking the busy harbour. Tug steamers can come alongside to embark passengers for ships in the Sound.

The building consists of three separate blocks, A, B, C, substantially built, well ventilated, and lighted, and in every respect well adapted to this purpose. Block A contains on ground-floor, depôt master and Colonial agents offices, a surgery, and a large mess-room ($58 \times 41{\cdot}6''$) for single women. On the floor above, a dormitory ($73{\cdot}6'' \times 41{\cdot}6''$), fitted with washstands, &c., with accommodation for 248 single women, and a separate berth for the matron. Block B, ground-floor, depôt master's quarters and two large store-rooms for baggage, and over these a dormitory ($57{\cdot}6'' \times 41$), available for married couples or single men, as required. Block C communicates with block B by means of a covered way. On the ground-floor are situated the kitchen, provided with ample and excellent cooking apparatus, a large provision store-room, separate lavatories, with baths for men and women, and a disinfecting chamber heated by gas, in which I am informed a high temperature can be maintained. On the first floor are two large mess-rooms fitted with tables and forms. Second-floor dormitories for 100 married couples, and on the third-floor dormitories for 120 single men. At the end of this block, on the first and second floor, and cut off from the remainder of the building, are two wards well adapted for the reception of suspected cases of infectious disease.

The waterclosets are situated in the yard, and discharge into the harbour; thus the contents are removed by the tide. There is, however, a considerable surface of rock above high-water mark upon which excrement lodges and decomposes.* The drainage of the depôt runs direct to the harbour, and there is no communication with the town sewer. At the entrance to the depôt there is a lodge for the gatekeeper. Paper, pens, soap, and other articles which emigrants are likely to require are kept for their use, and supplied to them at a reasonable cost to prevent the necessity of their going into the town. The buildings throughout were well ordered and in a very satisfactory cleanly condition.

Infectious hospitals.

The urban sanitary authority possess an *infectious hospital*, situated in the workhouse grounds. It is a small building, insufficiently ven-

* *June* 1883. Whilst this Report is passing through the press, several cases of typhoid fever have occurred at the depôt amongst certain emigrants who had embarked in health, but returned after an absence of twenty-four days owing to the ship having become disabled at sea. The fever manifested itself within a day or two of their return, and was attributed to impure water on board the ship. Subsequently the disease spread at the depôt, and continued to prevail there more or less for some six or seven weeks; the channel of infection there was probably the privies which had become specifically infected by the evacuations of the first sufferers. August 6th. I am informed that the offending privies have now been removed, and self-cleansing trough-closets of approved pattern substituted.

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tilated, crowded with beds, and altogether ill adapted to the purpose of a hospital.

In the spring of 1881, the port sanitary authority obtained from the Admiralty the loan of the "*Pique*," an old wooden sailing frigate, to be used as a *hospital*. She is now anchored in the Sound in charge of a man and his wife, whose duty it is also to attend upon the patients. I visited the "*Pique*" and found her lying in an exposed position, where, indeed, I have myself seen vessels driven on shore by force of the wind and sea. The ship is roomy and a fair height between decks, the sides of the cabins and sick bays are painted, and the deck overhead whitewashed. She had been thoroughly limewashed below and was generally clean throughout. The bilges were fairly free of water, and there was no perceptible smell from them till the water in them was disturbed, when it gave off offensive effluvia. The ventilation of the decks was effected by means of hatches, ports, and side scuttles, and that of the bilges by two canvas windsails. There is no provision for heating the air between decks, nor for the efficient disinfection of clothing, &c. The old cooking galley remains, and in addition there is a smaller one, affording together ample provision for culinary purposes, heating water for baths, &c. There is only one accommodation ladder, but the ship is fitted with a derrick by means of which the sick can be hoisted on board in a canvas cot prepared for the purpose. Some five or six cases of small-pox have been treated on board, but there is no separate accommodation set apart for such cases.

The use of the "*Pique*" as a hospital has much to commend it, being handy for seamen, and preventing the necessity of landing infectious cases and conveying them through the town. On the other hand, wooden ships are apt to retain infection and so endanger the health of persons brought on board. Again, the position of the ship is a serious objection, in view of the necessity that exists for the medical attendant at all times to find the ship easy of access, particularly when dangerous cases are under treatment. With regard to the use of a canvas cot for hoisting patients in, I would suggest the substitution of one made of non-absorbent material, such as thin strips of iron placed two or three inches apart, canvas being liable to retain infection; this applies also to the canvas windsails. Further, chloride of zinc should be freely and frequently applied to the bilges to insure their being kept in a wholesome condition.

(4.) Glasgow. *The emigrant lodging-houses* at Glasgow are numerous. They are not considered in the light of common lodging-houses, but are registered under the head of "houses let in lodgings" (Public Health Act (Scotland), 1867, section 44), and are regulated by byelaws, which require 300 cubic feet of space to be allotted to every individual over eight years of age, and provide for the due cleansing and ventilation of the houses, and for notice being given to the authority on the appearance of any infectious disease. The houses are systematically inspected by officers belonging to the sanitary authority. The first that came under observation is used solely by Colonial emigrants, and is appropriated to married couples and single women, the accommodation for the former consisting of several moderate-sized rooms, and one large room fitted up in a manner to secure privacy, while the single women's quarters are in a separate part of the building. Single men are received into a separate house. The other lodging-houses visited were full of transmigrants, and were in a satisfactory condition, excepting some of the closets which are on the tub principle and required cleansing.

Glasgow. (Lodging-houses.)

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come under my observation, directing their attention to certain entries in the inspector of nuisances report book, which showed instances of overcrowding to have been reported, and no action taken in the matter. It then transpired that the medical officers of health had recommended 300 cubic feet, but the authority, unknown to them, had adopted 250 cubic feet as the standard. I endeavoured to impress upon the authority that 250 cubic feet was too low a standard, naming 300 as the minimum that should be allowed, and 350 or 400 as more conducive to health.

The chairman appeared to fully appreciate the importance of emigrants embarking in good health, and he promised measures of improvement. With regard to the water supply of the town, he said that that question was then under consideration of the Queenstown Authority, and they were in hopes of securing a new supply which they were in treaty for.

Infectious hospital.

Cases of infectious disease occurring in the town are taken to the General Infirmary, where they are accommodated in special wards; but cases of such sickness occurring afloat are sent to an infectious hospital recently provided by the Cork board of guardians in their capacity of port nuisance authority. This hospital is situated near the beach, remote from dwellings, and convenient for cases landed from ships. But the accommodation, consisting of one ward only, and one small convalescent room, is already found to be too limited; thus, on one occasion the ward being pre-occupied by a small-pox patient, a case of scarlatina could not be admitted, and was therefore relegated to the General Infirmary, where cases of sickness occurring amongst emigrants are also received.

I pointed out to the clerk to the authority the advisability of adding to the port hospital, so as to increase the amount of accommodation.

Ocean Steamships.

Embarkation of emigrants.

The emigrants are usually taken off to the ocean steamships in tugs, but in London they sometimes embark at the dock, and pass down the river to Gravesend, where the ship anchors for the night; or they are sent by train to Tilbury, where tugs are in waiting to convey them to the steamer. At Glasgow the embarkation sometimes takes place at the shipping wharf, but more generally the emigrants are conveyed by train or small steamer to Greenock, and then by tugs to the ocean ship.

Vessels boarded, and their destination.

We boarded and inspected ships at the ports of London, Liverpool, Plymouth, Greenock, and Queenstown, and thus had the opportunity of seeing representatives of the magnificent fleets possessed by many of the principal shipping companies. Certain of the vessels were about to start for various parts of the world, including Australasia, the Cape, United States, and British North America.

General description of the steamers.

These full-powered screw steamers are built of iron, and are from 2,000 to 5,000 tons burden. Amongst the fleets are to be found some of the finest steamships in the world, combining symmetry of form, lines that insure speed, strength of construction, good carrying capacity, and great steam power. The internal economy of several of the ships was in keeping with their external appearance, possessing clear, roomy upper deck, palatial saloon, well-appointed cabins for first-class passengers, mess-rooms for officers, well-ventilated compartments for emigrants, capacious galleys fitted up with every convenience and requisite for cooking purposes, large, light, and airy engine-room, various store-rooms for provisions, ice-house, &c. There are three decks in part appropriated to the use of the emigrants, viz., the weather

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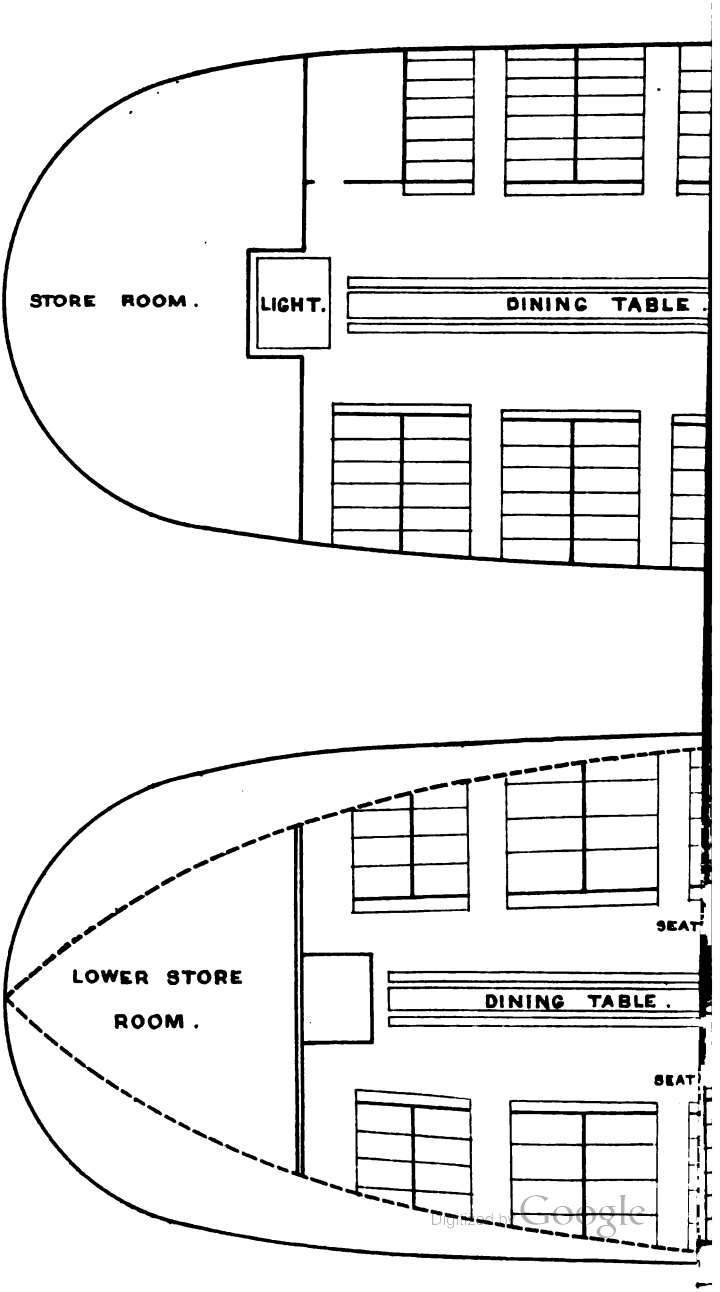
S . S. "SPAIN

TONS	451
LENGTH FT.	43
BREADTH	4
NOMINAL H.P.	60



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nd exercise, the upper and lower passenger decks, where
thed and take their meals, and below these again the hold,
go is stowed.

Passenger decks.

nger decks, with which we are principally concerned, are
e hatchways, which open to the weather deck, and by side
d at night by artificial light obtained from lamps of various
electricity, being one of the latest improvements. For
mps are so arranged that while affording ample light to
ing deck, they are inaccessible to the passengers. The
side scuttles, assisted by cowls and windsails, furnish the
ntilation, together promoting the interchange of air by
sh air to the deck and carrying off the foul air.

ng of the side scuttles open depends upon the state of the
ometimes indeed is so high as to necessitate the battening
hatches to secure the safety of the ship, when the ventila-
effected by cowls. Ventilation by fan has been tried, but
isfactory in the Anchor Line, where the fan serves to
air; on the other hand, in the Monarch Line, the fan acts
or of foul air and is used for cattle homewards, and doubtless
e for emigrants if found requisite either from stress of
he large number of emigrants.

Compartment.

ngers Acts require only the single men to be separated from
r of the emigrants, but owners have in numerous instances
arate compartments for the single women also. In some
partments are separated by bulkheads, in others the saloon
tween the single men's compartment and the others. As
compartment has a hatchway opening to the weather deck;
two instances the single women had to pass through the
ple's quarters on their way to and from the weather deck.

Sleeping berths.

partments are fitted up with great care to secure the comfort
pants. The sleeping berths are variously constructed and
A general plan is to have them in separate blocks of two
ove the other, extending from the side towards the centre of
e accompanying diagram), each block being divided into two
-divided respectively into four, five, or six berths, running
ft. The berths measure not less than 6 feet by 2 feet,
eparated from each other by a partition about 8 inches
ne of the berths are constructed of wood with shifting sides,
nt arrangement admitting of enlargement of the berths if
or the accommodation of children. Others have canvas
htly strained, which commends itself to me as being more
e to sleep upon, and offering facilities for cleansing by
Again, certain of the ships are provided with "Dewar's
nsformation steerage berths," which have the advantage of
a comfortable bed at night, and in place of this a form and
by day, combined with privacy. In one of the White Star
ound the married people's berths arranged to secure almost
rivacy as cabins, by means of bulkheads with a space left top
n for ventilation purposes. I am informed that great care is
leanse the fittings after each voyage, and that in the Austral-
s they are not infrequently destroyed on the disembarkation
igrants, in order to avoid encumbering the ship with them.

Bedding.

Atlantic trade it is not the practice of the shipowners to provide
rants with beds, and efforts are made, as far as possible, to
he emigrants to treat as luggage any bedding they may bring
m from their homes, and in that way have such things put

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below. But they are expected and encouraged to provide themselves instead with what are usually called emigrant beds; these consist of cotton material filled with oat-straw, and can usually be obtained at any port where emigrants embark for small sums varying from ninepence for a child to one shilling for an adult, superior quality one shilling and threepence. These beds are generally thrown overboard before arrival in America.

In the Colonial emigrant trade this practice does not prevail, and each Colony makes such regulations as it considers best for its own emigrants. The Cape Colony at the present time may be considered in the most advanced position in this respect, as the ship is required to provide mattresses, blankets, pillows, and bed linen.

Hospitals.

In the ships separate hospitals are provided for men and women. They are usually situated on the upper passenger deck (never below it), and are generally well lighted and ventilated. Each hospital was provided with beds ready for use. The ships were well found in medical comforts and requirements. Occasionally the key of the hospital was found to be in the hands of the steward, a circumstance which suggested the hospitals being put to other than their legitimate use, and which Captain Wilson, when doing duty at Queenstown, found to be the case in several instances, first-class passengers, ship's officers, stewards, and other members of the crew being accommodated in them in contravention of the Passengers Act (s. 24).

Some of the ships possessed hospitals for infectious cases situated on the weather deck, and although sometimes not well adapted to the purpose by reason of their position in the part of the deck frequented by the steerage passengers, and the want of efficient ventilation, still the provision of them in this open situation is a step in the right direction.

Accommodation for medical officers.

Here I would refer to the inferior accommodation we found provided for the surgeon, and which is not calculated to invite the services of desirable men, being altogether out of keeping with the responsible position the surgeon holds in the ship as entrusted with the care of the health of hundreds of men, women, and children. In some cases he has to stow himself away in the dispensary, surrounded by medicines and drugs, having no other place to sleep in. In other ships the cabin allotted to him is small, dark, and badly situated, thus in every way militating against his keeping any reasonable record of the cases of sickness that occur during the voyage. It is highly important that all such cases should be chronicled, especially with reference to infectious diseases; the want of such records has been experienced in the present inquiry, as will be presently shown.

Lavatories.

Most of the ships have separate lavatories for men and women, fitted with basins and washtubs, and provided with hot and cold water. These lavatories are not required by the Passengers Act; but they are essential to the comfort of the passengers and conducive to health. One or two of the ships had them for women only.

Closet accommodation.

The closet accommodation consisted of separate closets for men and women, quite apart, and usually on opposite sides of the deck. Some of the female closets were entered from the women's quarters below, and in one or two instances the closets and lavatories opened one into the other,—a bad arrangement for the women employed in the lavatories. The seats of the closets were arranged over a trough through which water is constantly flowing, when the ship is under weigh, by means of a pulsometer.

Iron decks.

I am informed that some ships have iron decks. I would observe that this is objectionable, as, unless sheathed with wood, the metal by

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causing condensation promotes dampness, and the use of bottom boards, which is sometimes resorted to, has the disadvantage of harbouring dirt in the interstices.

Care to secure the comfort of the emigrants.

Great care is bestowed upon the comfort of the emigrants, drinking water and barrels of biscuit being conveniently placed for persons to help themselves at will,—a privilege which many would probably avail themselves of when suffering from sea sickness and unable to take their meals; and in some ships they can obtain tea or coffee when they like.

The dietary is very liberal, the companies not restricting themselves to the scale provided by the Passengers Act, but in various ways exceeding this.

In most vessels matrons are in attendance in the women's quarters, and watchmen on duty day and night in other parts of the ship to check irregularity and preserve order.

The examination of these ships convinces me that the several companies to which they belong are without exception actuated by a laudable desire to promote the comfort and welfare of the passengers, and having myself, when serving in the Royal Navy, been employed for a while in troop ships, which are somewhat analogous to passenger ships, carrying soldiers with their wives and families, I am the better able to appreciate the measures adopted by them to this end.

Cattle ships.

Certain of the companies, including the Warren, Monarch, National, Beaver, and Lake Lines, are employed in the cattle trade, taking emigrants out to Canada and New York, and bringing large cargoes of cattle and sheep home to London and Liverpool.

The interior of such ships is constructed with a view of securing the entry of a large amount of fresh air on to the main and lower decks, cattle being specially intolerant of vitiated atmosphere and deprivation of oxygen.

We boarded one ship at Liverpool on arrival from Canada with 460 cattle and 1,300 sheep on board.

The decks where the cattle stood were some 2 or 3 feet deep in dung and litter, but the part of the ship free of live stock was quite clean. All the cattle and sheep were landed in fine condition, speaking well for the successful management on board, and were at once driven to the reception lairs provided on the Birkenhead side of the river on a very extensive scale and admirably kept. The cleansing and disinfecting the ship was then proceeded with under the supervision of officers appointed by the Privy Council.

Another of these ships (Lake Line Company) was on the point of sailing with some forty emigrants on board, and several horses for transportation to Canada. The emigrants were comfortably berthed and seemed well cared for, and although a short ship, *i.e.*, having less than 50 passengers on board, she carried a surgeon, which the representative of the company informed me was their usual practice.

The smell of cattle perceptibly pervaded the ship, and while it may be open to question whether such effluvia are really injurious to health, still, considering the emigrants are living together in confined spaces, exposed to the motion of the ship, which induces sea sickness, there can be no doubt that the smell of cattle would, to say the least of it, materially increase their discomfort, more particularly in bad weather, when the hatches being closed the smell would be intensified. In connexion with this subject it must be recognised that ships engaged in this twofold traffic are able to carry emigrants at a lower rate (the amount subject to frequent alteration) than the regular passenger ships, charging in August last 4*l.* 10*s.* against 6*l.*, and so meeting the circumstances of the poorer emigrants. It would, therefore, be unwise to impose such

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restrictions upon the company as would preclude the continuance of the traffic at the reduced fares. At the same time the efficient cleansing of the ship cannot be lost sight of, and for this purpose it seems to me that a week at least should elapse between the discharge of cattle and the embarkation of emigrants. In the interval the side ports and scuttles should be left open, and thorough cleansing and disinfection of the ship carried out to the satisfaction of the port sanitary authority (Public Health Act, 1875, s. 91), instead of which I am told that at times these ships discharge their cargo of cattle and are "turned round" and despatched with emigrants in the short space of four or five days.

Manning the ships.

The manning of the ships is a subject that calls for observation. The Shipping Act for 1854, s. 122, requires that every local marine board shall establish a shipping office and appoint a shipping master and staff, whose duties shall include the affording facilities for engaging seamen by keeping registries of their names and characters (s. 124). The number of hands carried by ships is uncertain, as there is no crew scale legally compulsory. Owners do with as few men as they possibly can, but the emigration officer can refuse clearance if he considers the number insufficient for the safety of the emigrants (Passengers Act, 1855, s. 28).

The crew of a passenger steamer consists of captain and officers, seamen, firemen, and stewards. The seamen and firemen, with the exception of a few petty officers and leading men, are discharged to the shore directly a ship enters harbour on her return home, and before she sails again these vacancies have to be filled up. For this purpose the captain or his representative attends at the shipping office and engages for the voyage the required number of men, who sign articles of agreement, by which they bind themselves amongst other things to be on board on the day of sailing, and usually they are not required to appear on board before that time. This class of men are proverbially intemperate and irregular in their habits, and when the day comes for them to join, and the crew are mustered prior to sailing it not infrequently happens that some of the new hands will be in a semi-state of intoxication or suffering from dissipation, while some perhaps have not put in an appearance at all. Their places, however, must be supplied, in accordance with the requirements of the Passengers Act, to the satisfaction of the emigration officer. This is effected by picking up some of the loafers locally called "jumpers," who are always to be found hanging about seaport towns looking for a job. They are very unsettled in their habits and own to no regular work, but on occasions of this sort for consideration of a higher rate of wages than is usually given, they would start off to fulfil the purpose of a stop-gap. When a ship on her outward voyage has to call at another port she may be allowed to complete her crew there, as, for instance, an emigrant ship sailing from Liverpool may fill up at Queenstown, the Board of Trade officer stationed there being apprised by telegraph of the necessity for so doing.

The Cunard Line offers an exception to this system of manning, in that their crews are shipped the day before sailing and are subjected, together with the ship, to inspection by the owner, who repairs on board and after a searching inspection of the ship from stem to stern, and from upper deck to kelson, musters the crew and exercises them at fire-drill, manning boats, &c. Through the courtesy of Mr. McIver we had the opportunity of witnessing such inspection, and can testify as to the thoroughness with which it is conducted. This plan entails the expense of an extra day's wages to the men, but in return secures the ship's sailing in an efficient condition and ready to meet any emergency.

We are happy to be able to add that this practise has been adopted by some other well-known lines of steamers.

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PART III.

Dealing with communicable Disease.

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Precautionary Measures for the Prevention of the Introduction and Spread of dangerous Infectious Disease and Transmission thereof to other Countries.

General remarks.

Having followed the movements of emigrants and transmigrants throughout their course, from the date of their leaving home to their final embarkation at the various ports of the United Kingdom, inquiry is now specially concerned with the question as to how far the Public Health, Quarantine, and Passenger Acts are applicable to the requirements of the passenger traffic, in the sense of protecting public health against dangerous infectious disease, and as to what precautionary measures are adopted to prevent the spread of such disease, if it should appear.

In order to arrive at a just conclusion on this head, it will be necessary to review the particulars connected with the transit of the emigrants, in so far as they have any special bearing upon health.

To begin with intending emigrants:—

Precautionary measures. Colonial Governments.

The Colonial Governments, Canada excepted, before granting free or assisted passages to British emigrants, require, amongst other qualifications, that every applicant shall furnish a certificate to the effect that he is free from infectious disease, and has been vaccinated or had small-pox; a very wise provision, but one which loses its value in proportion to the length of time that elapses between the granting of the certificate and the final departure of the emigrant from home, seeing that in the meanwhile he may in various ways be exposed to infection and so contract disease.

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Shipping companies.

The shipping companies, on the other hand, observe no such precaution, their agents, so far as I could learn, having no instructions to inquire into the health of intending emigrants (British or foreign) as regards freedom from infectious disease, &c.

The Scandinavians and Icelanders, I am informed, are required by their respective Governments to undergo medical examination before they embark on board the Continental steamers, which in the busy season are crowded with passengers.

Custom house inquiry.

On arrival at the British ports these vessels are boarded by the custom house officer, who, in accordance with the requirements of the Quarantine Act, makes inquiry of the captain as to the health of the ship agreeably to a prescribed form which the captain is required to sign, when, if the report be satisfactory, the passengers are allowed to land. Here I would submit that this sort of inquiry is not calculated to detect the presence of infectious disease, for the custom house officer is not acquainted with its nature, and the captain, with his multifarious duties to attend to, can hardly be expected, in a short passage of from 40 to 80 hours, to know much about the individual state of health of the hundreds of passengers on board, hence infectious sickness might be present in the ship without coming to his knowledge, when, he through ignorance giving a favourable report to the custom house officer, the infected person would be landed along with the other passengers, to the imminent risk of spreading disease on shore. For the sanitary authority are not concerned with the debarkation of transmigrants; thus it happens that a ship once passed by a custom house officer, the passengers are free to proceed on their way, going, if in London, direct to lodgings, but at Hull, Leith, and Granton, to the railway stations for conveyance to the various ports of embarkation, where they remain in lodgings till the time comes for them to start on their outward voyage.

Obviously, from first to last in the course of their transit, a certain amount of personal intercommunication must take place between the transmigrants themselves and others, either at the lodging-houses where, as at Hull, they stop for refreshment on their way from the steamer, or at the railway station, or it may be en route by train; their travelling or not with other passengers depending upon whether they have a special train allotted to them or not. In any case, the casual intermingling that necessarily takes place calls for mention as a ready means of spreading disease, should such chance to be present amongst the transmigrants or those with whom they come in contact.

Exposure to danger of infection in lodging houses.

In like manner as regards the lodging-houses at the various ports, their situation in thickly populated localities, together with the unrestricted intercourse which goes on between the transmigrants and the inhabitants of the place, offers free opportunity for the transmigrants, on the one hand, to introduce diseases into the town, or on the other hand, to contract infectious disorders from the townsfolk, the latter risk being considerable at times of epidemic prevalence, as, for example, at Queenstown where typhus fever was present prevailing throughout 1881, and continuing up to the time of my inquiry in September 1882. I am informed by Dr. Townsend that the first case appeared in January 1881, and from that date to the time of my visit the town was never free of the disease, fresh cases appearing every month varying from two in February 1881 to 21 in March 1882, in all 217 cases. The authority persistently neglected to carry out measures to prevent the spread of the disease, although urged to do so by the medical officers of health, Drs. Townsend and Downing, and by Dr. Brodie of the Local Government Board of Ireland. How seriously the health of the emigrants was jeopardised

Typhus fever at Queenstown.

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may be gathered from the following abstracts of the correspondence that arose out of such neglect :—

On November 5th, 1881, Dr. Brodie reports; "An emigrant lodging-"house overcrowded, and cases of typhus fever removed *from this* "house to the hospital." He goes on to observe: "As the disease "has become endemic it is a matter of serious import to a thickly "populated locality, and great danger exists that germs of the disease "may be introduced into the emigrant ships, which would probably lead "the directors of the Transatlantic steamers to abandon Queenstown as "a port of call, and thereby entail an indescribable pecuniary loss on the "inhabitants." On December 28th, 1881, the Local Government Board of Ireland wrote to the authority to the effect that they would incur a serious responsibility if they continued to neglect to do their duty in this respect, and added that the Board proposed to send the correspondence to the Government with reference to the question of emigration from the port of Queenstown.

Subsequently to this the authority adopted the required measures, and at the time of my visit great improvement had been effected.

From the foregoing correspondence it will be recognised that the danger referred to was of a very grave character, threatening to involve the health and lives of passengers on board crowded ships, together with the risk of importation of the fatal disease into other countries.

Particular instances were not wanting where conditions favourable to the development and spread of typhoid fever were found to exist in the lodging houses at the several ports visited, such, for example, as untrapped drains in communication with unventilated sewers, foul cesspit privies, wells exposed to pollution through their situation in relation to privies, defective drains, or other contaminating circumstance; closets situated within the dwelling with no opening to the external air, and their soil pipes unventilated.

Medical inspection as provided by shipping companies.

Some of the shipping companies do not concern themselves at all as to the health of the transmigrants at the lodgings; others employ the surgeons of their ships or local practitioners to examine them during their stay there, and in this way cases of communicable disease have from time to time been detected and sent to hospital, and disinfection of the infected house carried out under the supervision of the sanitary authority. But as a rule these inspections are not of the frequent and systematic character essential to insure early detection of premonitory symptoms of infectious disorder; and in the event of indeterminate cases of sickness being detected, there are no rooms set apart in the lodgings where such cases can be isolated for observation purposes; hence they are suffered to remain a possible danger to their fellow lodgers and others with whom they come in contact before the disease declares itself.

Public Health Act and bye-laws.

True, the Public Health Act and the byelaws require that every lodging-house keeper shall give immediate information upon the appearance of any infectious disease in his house, and the law further imposes penalties for the wilful exposure of infected persons or things, rendering it incumbent upon the local authority to take action in such cases; but it is obvious that these provisions are not adapted to meet the exigencies of the passenger traffic, for although the lodging-houses are, save in the Metropolis, under the careful supervision of local authorities, these have no power to deal with cases of mere suspicion, hence it follows that when the law is called into operation it is often not until considerable opportunity of effecting mischief has been afforded through the unrestricted intermingling of infected and healthy emigrants at crowded lodging-houses.

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Further, it is in evidence that the lodging-house keepers not infrequently neglect to inform the sanitary authority of the presence of infectious disease in their houses.

Board of Trade medical inspection.

Prior to embarkation the emigrants are subjected to medical inspection by officers appointed by the Board of Trade. At Liverpool and Queenstown these officers hold permanent appointments on a fixed salary, but at other ports they are paid by fee in accordance with the provisions of the Passengers Act, s. 44. The inspection of the emigrants usually takes place as they pass on board the tug, but London, Plymouth, and Queenstown offer exceptions to this.

The following may be taken as a fair illustration of the scene enacted on board an emigrant ship on the point of sailing. First, the ship is inspected by the emigration officer and medical inspector to see that the requirements of the Passengers Acts are fulfilled. The crew are mustered and inspected as to health, boats are manned and manœuvred, to see that the men know their stations and that the gear is in good working order. Soon the tug comes alongside with the emigrants, the medical inspector, emigration officer, and certain officers of the ship being ready to receive them. Men, women, and children may be seen pouring in,—a mixed multitude of many nationalities, talking divers languages, and creating a very babel of tongues,—inquiring some for their goods and chattels, others for missing members of their families. Parents and children, husbands and wives, getting separated in the crowd, and all clamouring alike for attention at the hands of the officials. As they pass on board the emigration officer receives from them the counterpart of their contract ticket, asking their names, and checking them off one by one according to a prepared list which he holds in his hand, bidding detached portions of families to stand aside till the rest of them can be got together; in this way they pass on to the medical inspector, and from him to the officials of the ship, who direct them to their respective quarters, the heterogeneous mass gradually shaping itself into order. Soon a man is stopped, his blotchy face and blood-shot eyes carrying with him suspicion of infectious disorder; on closer scrutiny, however, this is found to be due to continued intemperance increased by a heavy bout of drinking the previous night, and he is allowed to pass on. Again, in another instance, the same symptoms are accompanied by a quick pulse, high temperature and other indications of acute disease, and the individual is rejected and directed to stand aside, when the passing-by is resumed. Presently a family of five or six healthy looking children come trooping forward; the medical inspector inquires as to their vaccination, examines the arms of two or three of them, and finds by chance no signs of the operation, when he directs the attention of the ship's surgeon to the fact. The next family is stopped as some of the children manifest symptoms which may be those of measles or scarlatina; these are accordingly referred back to await opportunity for closer examination, when should suspicion be confirmed, they are rejected, which involves detention of the whole family to prevent the separation of parents and children. In some cases circumstances compel the medical inspector to have the children undressed then and there for examination, and so the inspection proceeds until all have undergone the ordeal. The emigration officer and medical inspector complete their duty by comparing the counterfoils with the passengers lists, signing various papers certifying that the nominal list of crew and passengers is correct and the requirements of the Acts and regulations fulfilled. The scene is full of life and interest, affording abundant opportunity for the study of human nature under a variety of phases. There, may be seen the

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careless and thoughtless starting forth with a jaunty air as if on holiday bent; near them the earnest, thoughtful characters, feeling the responsibility of commencing life afresh; some, evidently full of high hopes for the future, others bearing signs of doubts and fears; others, again, full of grief at leaving their old homes and the country of their birth; this, however, is merely the natural pang at the severance of old ties, for they have had the bold heart and the high resolve to plan and carry out the project, and are not likely now to repent the step. Withal it is a goodly assemblage of sturdy, intelligent, self-reliant characters, such as any nation might be glad to welcome as an addition to its strength and wealth.

With regard to the character of the inspection, the medical officers are careful and painstaking; but the noise, bustle, and confusion on board must materially militate against the efficient performance of the duty. I witnessed the proceedings under favourable circumstances, in so far that the weather on each occasion was fine; had it been otherwise, and rain, wind, or snow added to the other difficulties, it would seem well-nigh impossible that the duty of inspection could have been carried out with anything like efficiency. Occasionally, in exceptionally bad weather, the emigrants are inspected between decks, but here the light is bad for the purpose.

In London, on occasions when the emigrants embark at the dock and pass down the river to Gravesend sleeping on board that night, they are not mustered for inspection until the following morning, obviously after free opportunity has been given of spreading infection in the ship, and thus nullifying to a great extent the object of these inspections.

At Plymouth the inspection takes place at the depôt, which offers exceptional advantages in the way of shelter, good light, and ample accommodation, with freedom from bustle and confusion.

At Queenstown the emigrants are inspected on the wharves, which is open to great objection, taking place in the open air, and obliging the medical inspector to make in public such examination of children and others as he may deem necessary.

Here the medical inspector is called upon to fulfil the additional office of assistant emigration officer. Accordingly having completed the medical examination of the emigrants on shore he repairs on board, when, should the steamer have left Liverpool short of crew with orders to complete at Queenstown, it devolves upon him to see this carried into effect; or should her machinery have broken down in her passage from Liverpool he has to report to the emigration officer who exercises his own judgment as to the desirability of detaining the vessel till the defects shall be made good.

Altogether the duties imposed upon him at this port are important, for the condition in which the ship is found after her run from Liverpool may probably be taken as an index to what she will be for the rest of the voyage; and, as already mentioned, Captain Wilson, when employed at this port, found many instances of misappropriation of the hospitals, which could scarcely have been the case when the ships cleared from Liverpool.

Short ships.

Ships carrying less than 50 passengers are styled "short ships," and are not required to carry a surgeon unless the total number of persons on board exceeds ninety-nine; nor are the emigrants subjected to medical inspection by the Board of Trade inspector.

Bill of health.

It may be mentioned that the captains of ships going to foreign ports are required to provide themselves with a "bill of health" duly attested, usually signed by the custom house officer, certifying that the

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ports sailed from are free from cholera or other dangerous infectious disease.

The fact of these documents being signed by an officer of the customs, who is not in communication with the health officers, appears to me to detract from their value.

At Queenstown the "bill of health" is signed by the assistant emigration officer, who informs me he knows nothing about the health of the port, and has no opportunity of gaining such information. As already said, he is a medical practitioner and knows the occasion that exists for knowledge on this subject.

Disposal of rejected cases.

With regard to the *disposal of cases rejected by the Board of Trade medical inspector.* While the Passengers Act, s. 45, directs that the emigration officer shall order the *re-landing* of any person on board any passenger ship who is by reason of sickness unfit to proceed, or likely to endanger the health or safety of other persons on board, it makes no provision for the mode in which such re-landing shall be carried out, so as to secure to the people on shore similar protection to that afforded to those on board by the removal of the sick from the ship; as a consequence, the landing of such persons has resulted in spreading disease amongst the local communities where it has taken place, giving rise to well-founded complaints; as, for example, at Gravesend in 1878, when the urban sanitary authority, having represented to the Local Government Board that disease was spread in their district through the landing of infected omigrants, Mr. Netten Radcliffe, the assistant medical officer, was instructed to institute inquiry into the circumstances of the case After careful investigation he satisfied himself as to the justice of the complaint, and much correspondence ensued upon the subject between the Local Government Board and Board of Trade, also the Local Government Board and the sanitary authorities concerned (port sanitary authority of London and urban sanitary authority of Gravesend), with the result that an understanding was arrived at that in future all such cases should be sent direct from the emigrant ship to the hospital ship "Rhin," anchored off Gravesend, the Board of Trade agreeing to regard this in the light of re-landing.

At Gravesend.

At Glasgow.

Again, at Glasgow in 1881, Dr. Russell, the medical officer of health, reported to the board of supervision of Scotland that two cases of small-pox had been re-landed from an emigrant ship at Greenock, and sent to a lodging-house at Glasgow, where they passed the night in the same room with eight other emigrants; also, that cases of measles had been re-landed in a similar way and received into crowded lodging-houses. This report led to new and satisfactory arrangements being entered into between the Board of Trade officers, sanitary authority, and the shipping companies, by which all infectious cases re-landed from emigrant ships were to be taken to the infectious disease hospital, and notice thereof sent to the medical officer of health.

At Liverpool.

On examining the Board of Trade returns of rejected cases for 1881–1882 I observed that eight cases of small-pox were rejected and re-landed at Liverpool, and that two only are accounted for as received into the hospitals; the remaining six may have been sent to the West Derby Hospital, where I am told small-pox cases are taken, but I could get no satisfactory information respecting them. Dr. Spooner mentions two or three instances in which children rejected by him for measles and re-landed presented themselves a week afterwards for embarkation, when he ascertained that in the interim they had been staying at lodgings.

While at Liverpool I myself witnessed the rejection of some cases of measles by the Board of Trade inspector, and upon making inquiry as

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to the usual method of disposing of cases so re-landed, I was told that it was not customary to apprise the medical officer of health of the circumstance, and that it was doubtful what was done with them, whether sent to hospital, lodgings, or private houses. This re-landing has led to correspondence between the urban authority and the directors of the shipping companies, the authority pointing out that those in charge of the emigrants rendered themselves liable to penalties if they permitted the exposure of infected persons; but evidently, by my recent experience in the cases of measles above quoted, the correspondence resulted in no practical good. After consultation with Captain Wilson we advised that the medical inspectors of the Board of Trade should send immediate information of rejected cases to the medical officer of health, and that to facilitate his doing this, the sanitary authority should have printed forms prepared for the medical inspector to fill up and despatch to the medical officer at once, in order to enable him to take the necessary steps to insure the safe disposal of the cases. This re-landing is often complicated through the necessity of including therein whole families, when perhaps only one or two members are suffering. All, however, are sent to hospital together, which, besides causing much inconvenience to the establishment, involves the risk of the healthy ones there contracting disease. It is in evidence that disease has from time to time been thus spread to persons at Liverpool. At Glasgow this difficulty is met by sending the healthy members of the family into the reception house, already mentioned in connexion with hospital provision (page 156). The same with regard to suspicious cases, which it is clearly the duty of the medical inspectors to reject. These, according to present arrangement, are taken to an infectious hospital, thereby exposing such persons to terrible danger, supposing the suspicions should not be confirmed.

With regard to precautionary measures on board ship :—

Precautionary measures on board ship.

The Transatlantic steamers carry two medical officers as a rule where the passengers number 1,000 or upwards. The surgeon of the ship is in attendance at the Board of Trade medical inspections, and thus all the passengers pass under his observation, his attention being directed to any child whom the inspector may observe to be unvaccinated, and to any other points that may attract special notice. During the voyage it would seem that no daily systematic inspection is made by the surgeon with a view of detecting premonitory symptoms of infectious disorder. Such a precautionary measure would be of great value where large numbers of men, women, and children are congregated together on board ship, for it would enable immediate isolation to be carried out, instead of waiting until the case is developed and the sufferer so ill that the doctor is sent for. But in order to reap the full benefit of this measure it is important that means of isolation should be ready at command, which is seldom the case on board these ships, as hospitals for infectious cases are quite the exception. Another subject of regret is that the surgeons are not in the habit of keeping precise records of the cases that come under treatment, noting the dates of attacks, nature of disease, &c. Such information would prove very valuable, for it would enable the disease to be traced to its origin, and so placing it in the power of the shipping companies to take steps to prevent a recurrence of the danger, supposing it to be referable to infection at lodging-houses or other places over which they could exercise control.

With regard to precautionary measures against small-pox :—

Vaccination emigrants.

The Transatlantic shipping companies are very loyal in their endeavours to comply with the wishes of the National Board of Health of

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the United States on this subject, causing notices in different languages to be posted up in the lodging-houses and in the ships, warning passengers that unless provided with a certificate of vaccination they are liable, on arrival at the port of destination, to be placed in quarantine until vaccinated; adding, that the surgeon of the ship is prepared to give certificates to such persons as can show satisfactory signs of the operation, or, on the other hand, to vaccinate any persons who may require it.

I should state that I found the ships well provided with lymph, although certain of the directors informed me they had some difficulty in obtaining it.

No evidence is forthcoming as to the number of unvaccinated persons found amongst British and foreign emigrants, but from the manner in which the Vaccination Acts are carried out in the United Kingdom, the presumption is that few British subjects, at all events children, would be in this category.

Precautionary measures adopted by Colonial Governments.

The Colonial Governments evince a practical interest in the health and welfare of the emigrants whom they send out, and are specially careful to secure their vaccination. Each Colonial Government appoints a surgeon superintendent to take charge of the emigrants on board their chartered ships, issuing for his guidance instructions of an explicit and exhaustive character, requiring him to see that the provisions issued are in accordance with the specified scale, that the emigrants' quarters, bedding, &c. are kept in a cleanly, wholesome condition, and personal cleanliness observed amongst the emigrants. His instructions extend also to the maintenance of order and discipline, including the daily attendance of children at school. In short, it appears to me that nothing has been lost sight of that could tend to promote the comfort and well-being of the emigrants.

The Queensland Government requires the surgeon to examine the emigrants when they arrive on board as to their vaccination, and to vaccinate all doubtful cases.

South Australia and New South Wales provide for the medical examination of the emigrants prior to embarkation, requiring from the surgeon of the ship a certificate to the effect that he has fulfilled the duty carefully, and having rejected the sickly and unhealthy, the remaining emigrants are free from infectious diseases and have been vaccinated, re-vaccinated, or had small-pox, as the case may be.

The instructions require also that the surgeon shall keep a watchful eye over the emigrants during the voyage, so as to detect the first signs of infectious disease amongst them, and adopt timely measures to prevent its spread; South Australia citing the following instructive particulars of the measures successfully adopted by the surgeon of an emigrant ship to prevent the spread of small-pox on board:—

Extract of Report by Mr. Arthur Goullet, Surgeon-Superintendent of the "Spitfire" (1863), on the appearance of Small-pox in that Vessel.

"Two days after sailing, a boy, aged 9 years, was attacked with small-pox. He had been vaccinated by me previously to sailing, but the disease was then in a state of incubation, and had been brought from Leeds. He was immediately placed in the male hospital, with his father to attend upon him. The windows were barred with iron, to prevent things being passed out, and the door kept locked, the key being in my possession. No communication was allowed either with his friends or any other of the emigrants. The proper food and medicines were passed in, but nothing was allowed to be passed out, and dirty linen was thrown overboard. No person was allowed near the door or windows of the hospital, and the chinks in the bulkhead separating it from the female hospital were carefully caulked. Every possible means of

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ventilation and disinfection were unremittingly used, and I was the only person who had any communication with the patient and his father, and I used every precaution so as not to carry the contagion to others. The father was allowed air and exercise on the lee side of the poop at night, after all the other emigrants were sent below; and when the boy was convalescent, and desquamation had commenced, frequent baths in casks of warm fresh water were used, and after every bath fresh bedding and clothing made of blankets were supplied, and the old ones thrown overboard. The boy was not allowed to leave the hospital until desquamation had entirely ceased. He is much pitted. By these means the disease was happily prevented from spreading, although there were many unprotected people on board, for the vaccine lymph supplied me was ineffectual in twenty-four cases out of twenty-five."

With regard to ships' crews :—

Re-vaccination of ships' crews.

While the Transatlantic shipping companies are careful to adopt measures to secure the vaccination of emigrants, they, strange to say, neglect the same wise precaution in respect of their officers and crews, thereby leaving open a very likely channel for the conveyance of small-pox on board at the risk of its spreading in the ship and being carried to other countries, besides exposing their crews, whose services can ill be dispensed with, to the great danger of contracting the disease, more particularly in view of their being liable to be employed in attendance on infected passengers.

I attended a meeting of the directors of the various Transatlantic shipping companies at Liverpool, when I took occasion to refer to the number of cases of small-pox that had occurred amongst their crews, impressing upon them the great value of re-vaccination, and strongly advising that it should be carried out in regard to all employed on board their ships.

They concurred in the desirability of this step, but at the same time certain of them seemed to apprehend great and almost insurmountable difficulties in carrying it into effect, owing mainly to the system of manning the ships, the crews not being got together till on the point of sailing. I pointed out that if re-vaccination were made a sine quâ non of service, and carried out on board, no serious opposition need be apprehended from the stewards and standing part of the crew, while with regard to the irregular men, these would be done as they shipped, so that in the course of time they, too, would all be re-vaccinated, and the companies thus reap the advantage of having protected crews,—an issue so important that I had no hesitation in saying it would be to their interest to adopt this desirable step.

Of the other shipping companies, so far as I could ascertain, the Union alone require their officers and crews to be re-vaccinated, their instructions being very precise on the point directing that the surgeons in the company's employ shall satisfy themselves that all have been re-vaccinated within the last seven years; and shall certify the same in writing, naming any instances in which objections have been raised to conform to this regulation. Another proviso of the Union Company is that "the surgeon is invariably to be present when the crew sign articles, and in the event of any of them appearing sickly, he is to inspect them before allowing them to sign."

The charter-parties of South Australia and New South Wales require that the officers and crew shall be passed by a competent medical officer. New South Wales further requires that the certificate as to their being in good health shall, amongst other things, specify that they are free from every disease that is usually considered contagious or infectious; but with all this forethought no mention of vaccination or re-vaccination is made in the charter-parties. I observe, however, appended to the "Instructions to Surgeons," issued by the South Australian Govern-

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ment, a letter dated from the Central Vaccine Office, South Australia, June 7th, 1877, advising that re-vaccination should be resorted to in the case of emigrants and members of the crew who do not show three or four good vaccination marks, or who have not been re-vaccinated within seven years.

Summary of precautionary measures.

It will be seen by the foregoing detailed particulars of the manner in which the emigration from the United Kingdom is carried out that—

(1.) No efficient precautionary measures are adopted to prevent the introduction of infectious disease into the United Kingdom by "transmigrants."

(2.) With the exception of the medical certificate required by certain Colonial Governments from intending emigrants on applying for their passage, and the provision made by certain of the shipping companies for the medical examination of transmigrants at the lodging-houses, no precautionary measures are adopted to prevent the spread of epidemic disease by emigrants at the various stages of their course, nor to protect them against the risk of contracting disease at the ports of final embarkation.

(3.) That the Board of Trade medical inspection of emigrants on embarkation, to provide against the introduction of infectious disease into the ships, is conducted under difficulties, such as exposure to weather, &c., that militate against its efficiency.

(4.) That there is a want of due precautionary measures on board ship to guard against the spread of disease.

Inquiry as to the amount of infectious sickness.

It now remains for me to report to what extent infectious disease has prevailed amongst emigrants, and where contracted; for information on this subject I applied to the medical officers of health, the Board of Trade medical inspectors, the shipping companies, and the Colonial agents for returns and particulars of infectious sickness that had come under their cognizance, enclosing with my application to the shipping companies and Colonial agents, forms with special columns for the entry of "date of attack," "nature of disease," &c., &c., with a request that they would kindly fill them up and return them to me.

The medical officers of health supplied me with the required information, as did also the medical inspectors at Liverpool and Queenstown, but the medical inspectors for London and Glasgow could not do so, as they had kept no record of rejected cases. The chief emigration officer at Glasgow was enabled to furnish me with the particulars of cases rejected at that port.

With the shipping companies, I regret to say, my object was entirely frustrated owing to their medical officers, as already mentioned, having kept no record of the particulars of the cases which had come under treatment on board. This to me was a matter of surprise, having been accustomed, when serving afloat myself, to see all such particulars accurately chronicled in a daily sick list. One or two of the companies sent me lists showing so many cases of specified disease as occurring on the voyage, while one or two placed their medical logs at my service, but no where could I obtain data to enable me to form an opinion as to where the cases were contracted, whether at the lodgings or previously, or whether the symptoms of the disease were manifest at the time of embarkation and had escaped the notice of the Board of Trade inspector.

It is the custom of the Board of Trade at Liverpool to require the surgeons of emigrant ships when they return from a voyage to report in writing the amount of sickness they have had on board, which reports for the years 1881 and 1882, being still at the office of that Board, I was able to examine.

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From the information gathered from the various sources I propose to consider—

(1.) The amount of sickness observed amongst transmigrants:
  (*a.*) At the ports of debarkation;
  (*b.*) At the railway stations;
(2.) The number of cases of infectious disease occurring amongst emigrants (British and foreign), and received into certain hospitals;
(3.) The number of cases rejected by the Board of Trade medical inspector;
(4.) The number of cases occurring on board the ocean steamers;
(5.) Cases of small-pox amongst ships' crews.

Amount of infectious sickness at various stages of the emigrants route.

Infectious Sickness.

(1.) Transmigrants:

(*a.*) *At ports of debarkation.*

Hull (three cases of measles).

Dr. Airy reports the detection of three cases of measles amongst transmigrants at Hull. The first made known to the customs house officer on arrival in the port, and by him reported to the sanitary authority on the 12th September 1881. The second case detected by the emigration agent at the railway station on 26th September 1881, both cases being taken to the hospital. The third case was stated by one of the emigration agents to have been found and treated privately without being brought to the knowledge of the sanitary authority.

This fact, Dr. Airy observes, affords evidence of a certain amount of risk to the public health, which might become considerable if infectious diseases were prevalent in the countries whence the emigrants are drawn.

Leith (13 cases of measles).

On 24th August 1882 the "Camoens" steamer arrived in the Firth of Forth from Iceland after a ten days' passage, having been delayed by ice, and anchored off Granton, in the jurisdiction of the Cramond rural sanitary authority. On the previous day the agent received a telegram from Thursoe informing him that measles had broken out in the vessel. He at once applied to the custom house officer, who sent word to Dr. Smith, medical officer of health of the Cramond rural sanitary authority. This officer had not been long appointed and was quite ignorant of the course to be pursued; accordingly on receipt of the intelligence he went to Leith to endeavour to get advice. The following morning at *three o'clock* he was on the pier in readiness to board the vessel directly she arrived, which, however, was not till eight or nine a.m. She had 47 cabin passengers and 107 transmigrants on board. The medical officer, whom the Allan Company had put on board to take charge of the emigrants, reported 11 cases of measles. The Cramond authority does not possess an infectious hospital, and Dr. Smith, still being at a loss what to do with the cases, went to Edinburgh to consult Dr. Littlejohn, who unfortunately was out of town; he then went to Leith and saw the sanitary inspector, and afterwards called on the chairman of the sanitary authority, but he also was out. Thus baffled on all sides in his endeavours to get advice, he sent the inspector off to the Infectious Hospital at Edinburgh, and ultimately got the 11 children received there with their respective families, in all 44 individuals, the children being conveyed from the landing-place in cabs, the rest walking. All were lodged in the hospital for the night; the next morning the healthy ones were sent to lodgings, where subsequently two other of the children were attacked, making a total of *thirteen* cases.

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The remainder of the "transmigrants" landed from the "Camoens" were sent to Glasgow and are reported to have been forwarded to Canada in a compartment by themselves, but with what result I was unable to learn.

Railway station at Liverpool (three cases of scarlatina, nine cases of measles).

(*b.*) *At the railway station.*

On the 21st February 1882, upon the arrival of transmigrants from Hull at the railway station, Liverpool, three cases of scarlatina were detected by the emigrant agent and sent direct to the infectious hospital. On April the 26th and 27th and on June 8th, two, five, and two cases of measles respectively were similarly detected and sent to hospital, making a total of 12 cases of infectious disease thus removed.

Cases received into infectious hospitals.

(2.) *Infectious cases received into hospital.*

(*a.*) *Liverpool Hospital.*

Liverpool.

TABLE 6.—CASES of INFECTIOUS DISEASE received into LIVERPOOL HOSPITAL in the 18 months, January 1881—30th June 1882, from among intending Emigrants (mostly being Foreigners).

YEAR.	NUMBER OF CASES OF								
	Small-pox.	Measles.	Scarlatina.	Diphtheria.	Whooping-cough.	Fever.	Erysipelas.	Chicken-pox.	Total.
1881	2	40	15	—	—	3*	—	—	60
1882	—	119	17	—	—	3*	—	—	139
Jan.—June.									
TOTAL -	2	159	32	—	—	6	—	—	199

* One case in each year was "typhus."

The above cases, with the exception of the two of small-pox, were received into the workhouse hospital, where they came under the observation of Dr. Robertson, who, in forwarding me the return, expressed his regret at being unable to give the nationalities of the sufferers and dates of attack. He supplied me, however, with the following valuable information with regard to the cases of measles and scarlatina: that some of the sufferers were attacked before they arrived at Hull, that they were sent on to Liverpool by train with the eruption full out upon them in company with a large number of emigrants; further, that two cases of scarlatina that had come through Hull were desquamating freely when admitted to hospital;* also that several cases of measles and scarlatina were admitted to the hospital from lodging-houses, where they had been kept for several days after they were attacked, and this notwithstanding that the house at the time was full of emigrants; further, he states that the two cases of typhus fever were traced to infected houses in the neighbourhood of the lodging-houses where the emigrants were staying. Dr. Robertson remarks that for the want of some place where

* *April* 1883. Whilst this Report is going through the press I learn from Dr. Taylor that cases of measles and scarlatina have recently been received into the Liverpool Hospital in persons recently landed at Hull. From consideration of the observed stage of the disease, there could be no doubt that it might have been detected at Hull, if the passengers had been medically examined there.

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emigrant families can be received, when one or two of the members are attacked with infectious disease, whole families have to be taken into the hospital, with the result that several healthy children have contracted disease there.

(*b.*) *Glasgow Hospital.*

Table 7.—Cases of Infectious Disease received into Glasgow Hospital in the 18 months, January 1881—30th June 1882. Glasgow.

Year.	Number of Cases of								
	Small-pox.	Measles.	Scarlatina.	Diphtheria.	Whooping-cough.	Fever.	Erysipelas.	Chicken-pox.	Total.
1881	6	11	--	4	3	1	1	1	27
1882 Jan.—June.	3	24	1	—	—	—	—	—	28
Total -	9	35	1	4	3	1	1	1	55

Of the total 55 cases above given six only were British emigrants, sufferers from measles, two in 1881 and four in 1882.

With regard to small-pox:—In addition to the six cases recorded in 1881, two other cases were received into the hospital that same year, due probably to infected emigrants, one occurring in a servant girl at an emigrant lodging-house, the other in a labourer employed on board an emigrant ship; a third case (a girl) was rejected by the Board of Trade medical inspector and re-landed at Greenock and sent to the infectious hospital there, but it appears, from correspondence that ensued, that she was removed the same night from the hospital to a lodging-house at Glasgow, where she was seen by Dr. Russell, medical officer of health, and another physician, both of whom considered that the girl had recently suffered from small-pox, but was so far recovered as to be no longer in an infective condition; lest, however, there might be danger of her clothes spreading the disease, they caused them to be disinfected.

Of these nine cases four are reported as unvaccinated (one of these proving fatal), four as vaccinated, and one not noted.

On admission to hospital three of the cases were in the papular stage, showing it to be the second or third day of the attack; five were in the pustular stage, denoting from the fifth to the seventh day; and in the remaining case the eruption was passing off, leaving the débris on the skin, probably the 14th or 15th day of the attack. Again:—

Of the *five* cases in the pustular stage, Dr. Russell notes that *two* of them were landed at Leith on April the 18th and received into hospital on April 22nd; *two* left Copenhagen on April the 29th, landed at Leith on May 2nd, and were admitted to the hospital on May 5th. The particulars of the landing of the other cases are not noted, but the inference is that medical inspection on arrival at Leith would have detected the presence of the disease in all these cases, and secured their immediate removal to hospital and so prevented the danger to others incurred by their travelling in an infective condition from Leith to Glasgow, and there going into a crowded lodging-house, where they remained two or three days before they were taken to hospital.

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App. A. No. 14.

On Emigration and Immigration, &c.; by Dr. Blaxall.

Queenstown.

(*c.*) *Queenstown Hospital.*

TABLE 8.—CASES of INFECTIOUS DISEASE received into QUEENSTOWN HOSPITAL.

YEAR.	NUMBER OF CASES OF								
	Small-pox.	Measles.	Scarlatina.	Diphtheria.	Whooping-cough.	Fever.	Erysipelas.	Chicken-pox.	TOTAL.
1881	2	—	4	—	—	1	—	—	7
1882 Jan.—June.	—	7	—	—	—	—	—	8	15
TOTAL -	2	7	4	—	—	1	—	8	22

Apparently the above cases, with the exception of that from "fever," were landed from steamers which called at this port, on their way from Liverpool, to embark more emigrants. Another case of small-pox is reported to have been landed from the "Circassian" at Londonderry.

(*d.*) *London Hospitals.*

Small-pox in the Metropolis.

The information I was enabled to glean with reference to the health of emigrants at the Metropolis was very scanty, but I may give the following particulars of *two* cases of small-pox :—

On May 25th, 1882, a servant girl from 51, High Street, Whitechapel, an emigrant lodging-house, was sent to the London Hospital, but as she was found to be suffering from small-pox she could not gain admission there, but was sent to the Small-pox Hospital. The lodging-house in which the case occurred contained at the time many emigrants.

The second case dates from June 16th, 1882, when a man was landed at Blackwall from the "Capella" together with other emigrants, and all went to the lodging-house, No. 16, Wellclose Square. On the 21st the man was so ill that he applied to the London Hospital for admission, which, however, was refused, as the medical man there found he was suffering from small-pox ; he was therefore sent on to the workhouse, and thence to the Small-pox Hospital at Homerton ; in this way the case came to the knowledge of the relieving officer, and he gave notice to the inspector of nuisances, who at once visited the lodging-house, and there ascertained that the infected man had occupied a room with eight or nine other emigrants who the inspector found in the act of preparing to take their bedding off to the ship. This, however, he prevented, and had all the bedding in the room disinfected.

I endeavoured to follow up the movements of the emigrants from this lodging-house, with a view to ascertain if any evil had resulted from their exposure to infection, but I could gain no further particulars respecting them.

I learned upon inquiry at the Homerton Hospital that the man on admission there was found to have been suffering from small-pox for five days or so. A similar case was reported in 1879, but in this instance the sufferer, a girl, was landed at six o'clock in the evening so ill that she was at once taken to hospital.

I may also mention that I find by the report of the port medical officer of health of London that in May 1881 cases of small-pox

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were rejected in three instances by the medical inspector of the Board of Trade, viz., three alleged cases from the "Denmark" (one only proving small-pox), and one case each from the "Alsatia" and the "Queen." All were sent to the hospital ship "Rhin."

There can be little doubt that these cases went on board direct from one or other of the lodging-houses, but whether they embarked at the dock, and so went down the river to Gravesend and passed the night on board before they were medically inspected there is no evidence to show. Be this as it may, the medical officer goes on to state that the "Denmark" sailed on the 18th May with over 600 emigrants, and on her arrival in New York three or four fresh cases of small-pox had appeared, and the ship was quarantined and all were vaccinated by the health officer. On the return voyage one of the crew was attacked and died.

(3.) *Cases rejected by the Board of Trade medical inspectors.*

Liverpool Board of Trade medical inspection. Number of cases rejected.

The subjoined Table No. 9 is prepared to show the number of ships inspected at Liverpool by the Board of Trade medical inspectors, from the 1st January 1881 to the 30th June 1882; and the number of these ships from which cases of infectious disease were rejected, together with the number and specific nature of such cases.

Table No. 9.

Year.	No. of Ships inspected at Liverpool.	No. of Ships from which Cases were rejected.	Number of Cases rejected of each of the Specified Diseases.									
			Small-pox.	Measles.	Scarlatina.	Diphtheria.	Whooping-cough.	Fever.	Erysipelas.	Ophthalmia.	Chicken-pox.	Total.
1881	451	36	4	4	3	—	2	6	—	5	18	42
Jan. to June 1882.	231	30	4	19	2	—	—	7	—	—	8	40
Total	682	66	8	23	5	—	2	13	—	5	26	82

Comparing the above return of rejected cases with that of cases received into the infectious hospital, as given on the preceding Table No. 6 (page 174), an important difference is observed. Thus, as stated on page 168, eight cases of small-pox are shown to have been rejected, whereas two only are accounted for in hospital; in like manner, two cases of whooping-cough, seven of fever, five of ophthalmia, and 26 of chicken-pox appear in the return of rejected cases, in excess of the number of corresponding cases disposed of in hospital, and I have been unable to gain any information as to what became of them.

(4.) *Infectious sickness on board emigrant ships from Liverpool.*

Infectious disease on board Transatlantic ships.

Table 10 showing the number of ships that sailed from Liverpool during the 18 months from January 1881 to 30th June 1882, and the number of these ships that had infectious sickness on board during the passage to North America, and the number and specific nature of the cases that occurred as reported by the surgeons of the ships to the Board of Trade. (It is to be regretted that similar information was not forthcoming with regard to ships sailing from other ports and carrying about the same number of passengers).

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Table No. 10.

Year.	No. of Ships that Sailed from Liverpool.	No. of these Ships Infected during the passage out to N. America.	Number of Cases of									
			Small-pox.	Measles.	Scarlatina.	Diphtheria.	Whooping-cough.	Fever.	Erysipelas.	Ophthalmia.	Chicken-pox.	Total.
1881	451	61	25	97	11	—	—	8	—	—	2	143
Jan. to June 1882.	231	78	5	435	13	—	—	5	—	—	—	458
Total -	682	139	30	532	24	—	—	13	—	—	2	601

The above table shows (1) a marked increase in the number of infected ships in the six months of 1882; namely, 78 ships against 61 for the whole of the year 1881; (2) that this increase is due chiefly to measles, which is in keeping with the experience at the infectious hospitals at various ports (see preceding Tables 6, 7, 8), where measles is in excess of the other given diseases; while the evidence points to the disease having been chiefly amongst "transmigrants," cases of measles having been detected amongst them at the ports of debarkation and in their subsequent transit. This view is confirmed by the emigration agents. Again, with reference to the excess of infected ships in 1882, it is noteworthy that ships whence cases were rejected by the Board of Trade medical inspector also manifest a marked increase in the same period, as shown on preceding Table 9. But taking the whole period, cases were rejected in 10 per cent. of the ships examined, whereas 20 per cent. of the ships that sailed from Liverpool are shown to have had infectious disease on board, an important difference of which no data was forthcoming to afford explanation. With regard to the distribution of disease amongst the infected ships (Table 10). Of the 61 ships invaded in 1881, 12 had small-pox, 10 being the highest number of cases in any one ship; 35 had measles, 16 cases being the highest number; four had scarlatina, and 8 had "fever." Of the 78 ships in 1882, four had small-pox; 61 had measles, 39 being the highest number in any one ship; whilst eight ships had 15 cases and upwards; nine had "scarlatina," and five had fever. In addition to the cases given on the above table, certain ships are reported in each year to have had "several cases of measles" on board. The indefinite character of this information, together with the discrepancies between the returns supplied to me respectively by the Board of Trade and the shipping companies, leads me to the conclusion that the amount of sickness shown by the tables by no means represents all that occurred.

The epidemic prevalence of disease in certain ships would suggest a want of due vigilance on the part of the surgeon to detect the first indication of its presence in the ship, and so procure the timely separation of the sick from the healthy; or else a want of efficient means to carry out such isolation.

It has been stated (page 164) that in 1881–82, typhus fever was epidemic at Queenstown, but whether there was any connexion between this disease prevalence and the recorded cases of "fever" on board ship in those years there is no evidence to show.

Taking all the returns together, the recorded sickness in the 18 months January 1881 to June 1882, *exclusive* of rejected cases, amounts

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to a total of 895 cases; viz., 45 small-pox, 749 measles, 61 scarlatina, 4 diphtheria, 3 whooping cough, 21 fever, 1 erysipelas, and 11 chicken-pox.

Total amount of infectious sickness.

Of these 895 cases, 294 occurred on shore, and 601 on board ship. The cases on shore were detected, some at the ports of disembarkation, others at the railway stations, others again at the lodging-houses, thereby pointing to the disease in respect of British emigrants having been contracted before they left home; and in respect of transmigrants before they landed in the United Kingdom. It is further instructive to note the excess of infectious sickness detected at the embarkation ports of Liverpool and Glasgow, in comparison with similar detections at the ports of debarkation, Hull and Granton; thus, 3 cases only are recorded at Hull and 13 at Granton; whereas, at Liverpool and Glasgow the cases amount to 199 and 55 respectively, occurring mostly amongst transmigrants, and therefore shortly after their departure from Hull or Granton. Again, comparing London and Glasgow, which in this instance may fairly be done, seeing that in 1881 about an equal number of emigrants embarked from each port, viz. 44,000 and 42,000 respectively, London shows 1 case only of infectious disease received into hospital, against 55 admitted into Glasgow hospital. The probability is that other cases occurred in the Metropolis but never came to light, remaining it may be in lodgings a danger to others, or finding their way into one or other of the hospitals without coming to the knowledge of the sanitary authority. With regard to the 601 cases on board, there is no evidence to determine where these were contracted, but in all likelihood some of them were due to exposure to infection *en route* from the port of debarkation to that of embarkation or at the lodgings.

This amount of preventible sickness assumes considerable importance in view of the fact that it occurred in persons who presumably would leave their homes in good health, and that the passage in which the vessels were engaged was of short duration. And the whole burden of this inquiry goes to show a great deal of avoidable exposure to infection and consequent dissemination of disease, suggesting forcibly the necessity of adopting efficient precautionary measures to protect emigrants from disease, seeing that scarcely could a greater misfortune befall them than to be attacked with dangerous sickness just as they are about to commence life afresh in a new country. Such a calamity might seriously jeopardise their chance of success and blight their whole future career.

I found a very general opinion prevailing that measles was a disease of so trifling a nature that getting it on board ship was a matter of little consequence. But I endeavoured to remove this erroneous idea, explaining that at times the disease assumes a very virulent form, quickly proving fatal, and that damp and cold, conditions often met with on board, greatly conduce to this result, while the sequelæ, even after mild attacks, not infrequently produce lasting injury to eyesight and health. It is highly probable that, if the 532 recorded cases on board ship could be followed up, many of the sufferers would be found to have sustained some such permanent injury.

Infectious sickness amongst Colonial emigrants at the depôt.

From the returns supplied to me by the proprietor of the Plymouth depôt, I find that, out of a total of 12,760 *statute* adults that passed through the depôt in the 18 months ending 30th June 1882, two cases only of infectious diseases are recorded as occurring amongst them, viz., one of measles and one of scarlatina.

On board chartered ships.

These emigrants embarked in 44 ships chartered by the New South Wales, Queensland, and South Australian Governments, and the Agents General inform me that during the voyage five ships suffered from

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infectious sickness, viz., four ships from measles, with 22, 4, and 2 single cases respectively, and the fifth ship, from scarlatina, 2 cases.*

These returns deal with small numbers in comparison with the Transatlantic ships, but the immunity from infectious sickness at the Plymouth depôt, and the small amount occurring in the ships, together with the entire absence of small-pox, goes far to commend the depôt system, together with the precautionary measure adopted by colonial governments in requiring a certificate from intending emigrants to the effect that they are free from infectious disease, and have been vaccinated or had small-pox.

(5.) *Small-pox amongst Ships' Crews.*

Small-pox amongst the crews of passenger ships.

Small-pox has from time to time attacked the crews of ships belonging to various companies, contracted in some instances through attendance on infected passengers; the disease in certain ships manifesting a persistent character.

The "Denmark."

The steamship "Denmark" has already been cited as having had small-pox amongst the passengers on her way out to New York, when one of the crew contracted the disease and died on the passage home.

The "Victoria."

In the "Victoria" small-pox appeared amongst the passengers on her way out from London to New York, and the surgeon and two stewards are reported to have contracted the disease in assisting a lady passenger to disembark there.

The "Republic."

In the "Republic" a steward contracted the disease through attendance upon an infected passenger.

The "Peruvian."

In the "Peruvian" the first sufferer was a passenger attacked on the outward voyage, followed by two firemen and a steward; two other firemen being attacked on the homeward voyage.

The "Winconsin."

The "Winconsin" offers such a typical example of the manner in which small-pox may be spread, that I give the particulars in full.

This ship arrived at Liverpool from New York on the 28th May 1881 with two cases of small-pox on board, one a passenger, the other one of the crew. Both cases were removed to hospital. Two of the other passengers landed and proceeded to St. Austell in Cornwall, where they shortly sickened with small-pox. The rural sanitary authority reported the circumstance to the Local Government Board, complaining that small-pox had been introduced into their district by infected passengers from Liverpool.

The Local Government Board accordingly wrote to the sanitary authority of Liverpool, requesting to be supplied with information upon the subject; and in reply received the following letter from Dr. Taylor:

"The medical officer of health begs to report that the 'Winconsin' arrived in the Mersey on the 28th of May, having a passenger on board suffering from small-pox. The patient, and the man who had been in attendance upon him and showed slight symptoms of the disease, were removed to the Netherfield Hospital; the bedding and wood-work of the cabin which they had occupied was burned, and the vessel thoroughly disinfected. The medical officer of health was informed that a number of miners returning from Nevada had joined the ship at New York, and as soon as the vessel got out to sea the small-pox case was discovered, having been taken on board without the knowledge of the ship's

* *August* 1883. While this Report is going through the press it has come to my knowledge that the "Duchess of Argyle" sailed from Plymouth for Sydney on the 16th November 1882 with 444 emigrants, and six weeks afterwards scarlatina appeared on board. The surgeon of the ship reports the "outbreak to have been "coincident with the opening out of the passengers' luggage which had previously "been in the hold of the ship," and he infers that the outbreak was due to infected clothing. Would not such occurrences as these, if duly investigated and recorded, combine into a body of information that would be ultimately of considerable use?

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surgeon. The persons mentioned by the medical officer of St. Austell were no doubt friends of the sick man, and had accompanied him from Nevada, but they did not manifest any signs of the disease upon their arrival at Liverpool, and could not therefore be prevented from proceeding on their journey."

On the 4th June the "Winconsin" sailed again, and on arrival at Queenstown a fireman was sent to the infectious hospital with small-pox and died.

Before reaching New York eight other cases occurred, and were sent to hospital there. Meanwhile, on the 8th of June, one of the crew who came home in the "Winconsin," but did not go out in her again, and who resided at 47, Hopwood Street, was sent to Netherfield Hospital with small-pox, and subsequently a number of other cases occurred in the same locality, and apparently owed their origin to this man's case.

Now the small-pox apparently appeared very soon after the vessel had sailed from New York, so soon that had the passengers been subjected to careful medical inspection, the embarkation of the infected person would most likely have been prevented; instead of which the disease was introduced into the ship where it spread amongst passengers and crew, and was subsequently conveyed to St. Austell, Queenstown, and Liverpool, and taken back to New York on the return of the "Winconsin" to that city. Besides the steamships above quoted, the "Garonne," the "Rakaia," the "City of Brussels," the "Bothnia," and the "Lord Gough," may be mentioned as examples of vessels in which small-pox attacked the crews. The fact of the crews in so many instances being amongst the sufferers from this fatal disease, is a forcible illustration of the danger incurred through their not being protected by re-vaccination, more particularly where they are employed to attend upon infected passengers.

Mortality on board Emigrant Ships.

With regard to the amount of mortality on board emigrant ships, the only information I have been able to get under this head is contained in a return published by the Board of Trade in obedience to an order from the House of Commons, showing the number of passengers embarked on board British vessels for North America, Australasia, Cape of Good Hope, and Natal, during the year 1881, and the mortality on board those vessels amongst the passengers and crews, classified according to the lines to which the vessels belonged.

I would observe that the value of the said return would be greatly enhanced if the causes of death were specified, also the number of ships of each line that sailed, and the number of passengers and crew respectively that embarked in each ship, together with the deaths that took place amongst them. Deaths from suicide and drowning should, I think, be given separately, the latter being accidental, and when amongst the crew incurred probably in the execution of their duty or perhaps in their humane endeavour to save life.

It will be seen by the subjoined table abstracted from the return above referred to, that out of a total of 63,492 children that embarked in the Transatlantic ships 114 or 17·95 per 10,000 died; and out of a total of 315,850 passengers (adults and children) 186 or 5·8 per 10,000 died. In the absence of further particulars this mortality seems excessive, considering it occurred within twelve days of sailing in persons who it is supposed would start in good health, and who with a view to insure this are medically inspected, save in the less important case of "short ships," on embarkation.

Again 10 deaths are recorded of infants born on board; apparently a high number, but probably admitting of explanation by premature births brought on by sea-sickness or other causes; more precise information

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being required on this point as well as to the number of births which took place.

With regard to the Australasian ships, out of a total of 2,903 children 26 or 89·5 per 10,000 died, and out of a total, 16,764 passengers, 54 or 32·2 per 10,000 died. Comparison cannot for various reasons be made between the respective mortality of the Australasian and Transatlantic ships, the passage to Australasia occupying so much longer a period than that to North America, besides involving considerable changes of climate and long exposure to tropical heat: conditions that exercise an important influence upon health. This, however, would not hold good to the same extent in respect of liners bound to the same part of the world, but here again before the figures can be of value in the way of enabling such comparison to be made, information is required under the several heads herein-before noted, and, as regards Australasia, particulars also as to the precise route taken, whether by the Suez Canal or by the Cape, and the colony visited; the voyage to New Zealand occupying some twenty or thirty days longer than that to Sydney.

TABLE 11.—EMIGRATION MORTALITY IN 1881.

NORTH AMERICA.

LINE OF VESSELS.	NUMBER OF PASSENGERS.			DEATHS.			
				Passengers.			
	Adults.	Children and Infants.	Total.	Adults.	Children and Infants.	Total.	Crew.
Allan Line	32,743	8,465	41,208	6	10	16	—
*American Line	13,198	4,144	17,342	4	16	20	—
Anchor Line	28,238	8,105	36,343	4	23	27	1
Barrow S.S. Company's Line	840	179	1,019	—	2	2	—
Beaver Line	87	25	112	—	—	—	—
Cunard Line	34,465	7,411	41,866	4	10	14	3
Dominion Line	4,580	1,161	5,741	1	3	4	2
Great Western S.S. Company's Line	507	170	677	—	—	—	1
Guion Line	18,857	5,665	24,522	10	8	18	—
Inman Line	38,128	8,262	46,390	8	6	14	1
Monarch Line	2,638	1,119	3,757	2	3	5	—
National Line	30,085	8,090	38,175	8	15	23	3
State Line	13,651	3,890	17,541	2	10	12	—
Warren Line	4,187	1,162	5,349	—	1	1	—
White Star Line	30,164	5,644	35,808	6	7	13	1
TOTAL	252,358	63 492	315,850	55	114	169	14
ADD—Suicides and Deaths by Drowning				7	—	7	10
„ Deaths of Infants born on the Voyage				—	10	10	—
TOTAL DEATHS				62	124	186	24

AUSTRALASIA AND PLACES EN ROUTE.

British India S.S. Company's Vessels	938	168	1,106	3	3	6	—
Orient Line	7,784	1,285	9,069	11	3	14	3
"Miscellaneous" (not classified)	5,139	1,450	6,589	6	20	26	3
TOTAL	13,861	2,903	16,764	20	26	46	6
AND—Suicides and Deaths by Drowning				2	1	3	6
„ Deaths of Infants born on the Voyage				—	5	5	—
TOTAL DEATHS				22	32	54	12

* The return for this line refers only to British ships chartered by the American Steamship Company of Philadelphia.

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TABLE 11.—EMIGRATION MORTALITY IN 1881—*continued.*

LINE OF VESSELS.	NUMBER OF PASSENGERS.			DEATHS.			
				Passengers.			Crew.
	Adults.	Children and Infants.	Total.	Adults.	Children and Infants	Total.	
CAPE OF GOOD HOPE, NATAL, AND PLACES EN ROUTE.							
Colonial Mail Line - -	3,984	534	4,518	3	—	3	—
Union Line - - -	6,775	1,404	8,179	3	2	5	1
TOTAL - - -	10,759	1,938	12,697	6	2	8	1
ADD—Suicides and Deaths by Drowning - -				1	—	1	4
„ Deaths of Infants born on the Voyage - -				—	—	—	—
TOTAL DEATHS - - -				7	2	9	5

INFECTIOUS DISEASE OF FORMER YEARS.

Recorded sickness amongst emigrants in former years.

Before closing this section of the report it seems desirable to refer to certain recorded particulars of dangerous sickness occurring amongst emigrants in former years, as illustrative of the manner in which it has been imported into this country; and of the terrible fatality that has marked the presence of infectious disease on board certain emigrant ships. Dr. Taylor at the International Medical Congress in 1881, when speaking on the subject of the importation of infectious disease into Liverpool, gave the following particulars with reference to cholera in 1866:

Cholera on board Transatlantic ships.

(1.) The steamship "England" sailed from the Mersey on the 28th of March, and six days afterwards a Dutch boy who embarked at Liverpool died of cholera, and by the time the ship reached Halifax, 12 days from sailing, 92 deaths had occurred; 86 out of 1,200 passengers, and six of the crew.

(2.) The "Virginia steam ship" sailed on the 4th of April with 721 passengers, and eight days afterwards three of the passengers (foreigners) died of cholera, and before the 23rd of May, 105 of the passengers had fallen victims to the disease.

(3.) The "Helvetia" sailed on 2nd May with 925 passengers, of which 527 were foreigners, some from Rotterdam, others from Germany. Shortly after leaving harbour two deaths occurred from cholera, and the vessel in consequence put back to Liverpool, and the passengers were transferred to hospital ships, where 46 deaths occurred, including the surgeon of the ship.

Several other vessels sailing from the Mersey for America had outbreaks of cholera on board.

Cholera and relapsing fever introduced into Liverpool.

The first recorded cases in the town occurred in an emigrant lodging house in two transmigrants who had intended embarking in the "Helvetia." These cases proved fatal on the 2nd of May, followed by two other cholera deaths in the same house (also transmigrants for the "Helvetia").

On the 2nd of July a resident of the town died, and from that date to 30th November 1,763 deaths from cholera took place.

The evidence here given points to the disease having been introduced into Liverpool by transmigrants.

The same with regard to relapsing fever which Dr. Taylor states was introduced into Liverpool in 1870 by transmigrants, and continued to prevail the two following years, causing in all 587 deaths.

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APP. A. No. 14.

On Emigration and Immigration, &c.; by Dr. Blaxall.

Cholera introduced into the Metropolis.

One more instance of the introduction of cholera by transmigrants may be adduced as threatening danger to the Metropolis. The steamer "Iris" arrived in the Thames in July 1873 from Kiel, Copenhagen, and Hamburgh, with 82 Danish and Swedish emigrants on board, who were landed at Blackwall and sent to lodging-houses in Whitechapel. A few hours after arrival there, two of them were attacked with cholera, one case proving fatal. This was reported to the Local Government Board, who instructed Dr. Buchanan to inquire into the case and take the necessary steps to prevent the spread of the disease. This he accordingly did, securing the removal of the remainder of the emigrants to the hospital ship "Rhin." The healthy emigrants were afterwards transferred to the "Osprey" for observation purposes. In all 28 cases occurred, with eight deaths. It would seem that this prompt action saved the Metropolis from an epidemic of cholera, as no further cases appeared.

On the 17th July the Local Government Board issued an order with regard to cholera, giving increased powers to local authorities.

Infectious diseases on board Colonial ships.

In contradistinction to the small amount of sickness shown to occur in the colonial chartered ships of the present day, I would refer to the very serious mortality which resulted from infectious disease on board four colonial chartered sailing ships in 1852 in their passage from Liverpool to Australasia, as shown in a return ordered by the House of Commons, and printed on the 8th of March 1853:—

(1.) The "Bourneuf," out of 754 passengers, lost 84, principally from measles and scarlatina.

(2.) The "Marco Polo" carried 887 passengers; of these 52 died principally from *measles*, the disease manifesting itself within 24 hours of leaving Liverpool.

(3.) The "Wanata." Out of 758 passengers, 48 died of what was characterised as "fever of a low type."

(4.) The "Ticonderoga" sailed from Liverpool on the 4th of August with 800 passengers on board, and arrived at Hobson's Bay on the 4th November, having lost 102 passengers from "scarlatina" and "typhus fever," and 300 cases of sickness (principally scarlatina) being then present on board.

It would appear that the mortality on board these four ships was chiefly amongst children.

PART IV.

Immigration and Intermigration.

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Immigration.

Immigration

The immigration into the United Kingdom from places out of Europe, although not assuming the important dimensions of emigration, is still very considerable, and, like emigration, of a fluctuating character.

The subjoined table supplied to me by the Board of Trade shows the amount of immigration into the United Kingdom from specified countries in the nine years 1873–81.

British and foreign are distinguished for the last six years 1876–81.

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TABLE No. 12.—NUMBER of BRITISH and FOREIGN IMMIGRANTS who arrived in the UNITED KINGDOM from Countries out of EUROPE and not within the MEDITERRANEAN SEA, in each of the Years from 1873 to 1881.

COUNTRIES WHENCE ARRIVED.	1873.	1874.	1875.	1876.			1877.			1878.			1879.			1880.			1881.		
	TOTAL.	TOTAL.	TOTAL.	British.	Foreign.	TOTAL.	British.	Foreign.	TOTAL.	British.	Foreign.	TOTAL.	British.	Foreign.	TOTAL.	British.	Foreign.	TOTAL.	British.	Foreign.	TOTAL.
United States -	68,556	100,527	80,045	54,697	—	72,592	44,878	15,915	60,825*	34,040	20,919	54,989	20,048	13,995	34,043	26,518	18,970	45,488	29,781	21,416	51,197
British North America - -	5,862	7,791	6,577	6,629	—	7,284	5,687	305	5,992	6,204	197	6,401	3,497	143	3,640	4,688	396	5,084	5,761	438	6,199
Australasia - -	2,574	1,892	2,108	2,579	—	2,761	4,637	65	4,702	4,207	196	4,403	4,967	327	5,294	5,910	380	6,290	5,877	431	6,308
Cape of Good Hope and Natal	9,444	7,919	5,498	7,499	—	1,920	8,688	1,470	10,329*	10,493	1,665	12,158	9,424	1,572	10,996	9,891	1,563	11,454	11,288	2,113	13,401
Other Countries -																					
TOTAL -	86,416	128,129	94,228	71,404	—	93,557	63,890	17,755	81,848	54,944	23,007	77,951	37,936	16,037	53,973	47,007	21,309	68,316	52,707	24,398	77,105

* The discrepancy between the total and the sum of the British and Foreign is accounted for by the number of Immigrants whose nationality was not distinguished.

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Reference to the above table shows the highest number of immigrants in any one year was 128,129 in 1874; and the lowest number 53,973 in 1879, being in inverse proportion to emigration, which in 1874 exhibited a decline, while in 1879 great activity is manifested, the numbers being more than one third in excess of the preceding year 1878. (*See* Table 3, page 134.)

The emigration and immigration returns together afford evidence of the immense amount of intercommunication maintained between this country and the United States; to which probably the shortness of the passage, combined with the facility and comfort with which it can be accomplished in the Transatlantic steamers has conduced. In all likelihood many of the so-called immigrants are virtually travellers selecting this route to the European continent.

Introduction of disease into the United Kingdom by immigrants.

As regards the introduction of infectious disease into the United Kingdom by means of immigrants. These stand on the same footing as crews of ships from foreign ports, being subject to inquiry by the custom-house officer, and if disease should be found amongst them the fact is reported to the medical officer of health, who takes the necessary steps to prevent the introduction of the infection into the port and into the country. In this way, Dr. Taylor reports, that since 1877 he has received information of 86 ships arriving from the United States with infectious disease on board, viz., 20 with small-pox, 35 with measles, 14 scarlatina, 1 diphtheria, 15 fever, and 1 yellow fever.

In 1880 scarlatina was reported to Dr. Taylor as being on board the "Scythia," but when the officer of the sanitary authority boarded the ship with a view of removing the infected person to hospital, he found the sufferer had been taken by her father to an hotel. Proceedings (under the Public Heath Act, 1875, s. 126) were taken against the father, and a penalty of 5*l.* inflicted.

Another case came under notice where a scarlatina patient was removed from a ship to the hospital without being reported to the medical officer of health.

Maritime Intercommunication between Home Ports.

Maritime intercommunication.

The immense maritime intercommunication that takes place between the various ports of the United Kingdom is carried on by vessels specially engaged in the passenger traffic and coasting trade.

It would be beyond the province of this report to attempt to treat exhaustively of the health of this large floating population, but my instructions extending to inquiry into the broad principles and conditions which regulate and control the movements of these vessels, I have deemed it well to consult the reports of the medical officers of health of Newcastle-on-Tyne, Sunderland, and Shoreham; these, together with the emigration ports herein-before referred to, being representative ports of the coasting and foreign trade.

Port sanitary administration

The Port Sanitary Authorities of London, Liverpool, Newcastle-on-Tyne, Sunderland, Southampton, and Shoreham appoint each a medical officer of health and an inspector of nuisances, to carry out the various sanitary duties of the port under the several provisions of the Public Health Act relating to nuisances and disease prevention, which extend to vessels in harbour in so far as they can be applied. These officers, under section 92, are required to inspect vessels in harbour as to their sanitary condition, paying particular attention to the accommodation provided for the crew with regard to cubic capacity, cleanliness, and provision for ventilation and light, also to the privy accommodation and

Inspection of vessels.

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the water supply, and reporting any condition or circumstance that may come under observation likely to exercise injurious influence upon health.

The facility or otherwise with which the various duties may be carried out, is greatly dependent upon the physical outline and general character of the port districts. For example, the port of London, with its length of river, numerous anchorages, and extensive docks, together with the crews generally living on board, entails considerable labour and attention. But with the aid of a steam launch much supervision is exercised over the shipping. Dr. Collingridge, port medical officer of health, reports 137,968 vessels as inspected in the last nine years, giving an average of 15,329 per annum, some at anchorages in various parts of the river, others in dock. There have also been a large number of vessels subjected to disinfection through infectious disease having occurred on board during their absence from England.

The reports of the port medical officers of health bear unanimous testimony to the beneficial results of these inspections, showing that whereas formerly from 50 to 60 per cent. of the vessels examined were found in an unwholesome condition, now only from 10 to 12 per cent. are so reported: while not the least gratifying circumstance is the readiness displayed by owners and masters to carry out the suggested improvements.

It appears that at Sunderland these inspections at first met with opposition from foreigners, but on a letter being addressed to the respective consuls ready compliance followed.

Bristol and Plymouth are examples of ports where very little is done to give effect to the Public Health Act. No inspectors of nuisances are appointed, nor is the sanitary condition of vessels made the subject of inspection. The same applies to Queenstown.

With regard to Scotland, here again there is no inspection of the sanitary condition of vessels, and the want of an amalgamated authority for port sanitary purposes greatly militates against the efficient administration of the Public Health Act (Scotland) in relation to vessels, and is moreover attended with much inconvenience and irregularity of proceeding. This was exemplified in the case of the "Camoens" steamer (referred to on page 173), which arrived in the Frith of Forth with 11 cases of measles on board and anchored off Granton in the local sanitary district of Cramond, where there is no infectious hospital. The medical officer of health of the Cramond district, having no instructions as to the course to be pursued in such emergency, spent some hours in vainly endeavouring to obtain advice, and at last got the infected persons landed and conveyed to the infectious hospital at Edinburgh. Now, had the "Camoens" anchored at Leith a little more to the eastward she would have come under the jurisdiction of the Leith sanitary authority, and the cases would at once have been taken to the infectious hospital there, but to have anchored at Leith would have entailed heavier port dues than anchorage at Granton, which, I am informed, is the reason the latter was preferred. Between Leith and Granton, a distance of about a quarter of a mile, *three separate jurisdictions* are concerned, viz., Leith, St. Cuthbert, and Cramond; such divided responsibility cannot be expected to work satisfactorily, and Dr. Littlejohn, Medical Adviser to the Board of Supervision of Scotland, tells me he has brought under notice of the several authorities the advantages to be derived from an amalgamation of their districts for port sanitary administrative purposes.

Greenock, on the south bank of the Clyde, labours under similar disadvantages, for, although forming one out of many sanitary districts

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that on either side abut on the waters of the river, it has, from its commercial status and its situation at the entrance of the long reach of river stretching up to the important town of Glasgow and beyond, come to be chiefly concerned in the sanitary administration of the port. It is, moreover, the station of the customs; thus vessels arriving from foreign countries are here boarded by the customs house officer, and any case of infectious sickness that may come under his observation is reported by him to the Greenock sanitary authority. They recognising the responsibility devolving upon them, and the vital importance, in their own interest as well as that of Glasgow and the surrounding neighbourhood, of adopting due precautionary measures to prevent the introduction of infectious disease, have drawn up, and issued for the guidance of their sanitary officers, and for the masters of vessels, special instructions respecting the landing and removal to hospital of infected persons, and the disinfection of the infected ships. At the same time they have brought under notice of the Board of Supervision the expense they have been put to in carrying out the sanitary duties which from circumstances have been thrust upon them; and I observe that Dr. Littlejohn in his report on the conveyance of infectious disease from Port Glasgow to Greenock, dated 30th July 1879, recognises the energetic action of the Greenock local authority, together with the expense they have incurred thereby, and the national importance of the work done by them.

There can be little doubt that an amalgamation of the several districts concerned would be attended with considerable benefit, and this view is shared in by the medical officers of health of Glasgow and Greenock, also by the sanitary inspector of Greenock, all of whom have had much experience of the working of the present system.

Detection of infectious disease in coastwise vessels and foreign traders.

To return to the inspection under the Public Health Act of vessels in English ports:—These inspections it must be remembered can include a portion only of the numerous vessels that are continually going to and fro, and, moreover, are made at times convenient to the officers concerned, and not necessarily immediately on the arrival of the vessels in harbour; they cannot, therefore, be regarded in the light of a completely preventive measure; nevertheless, the medical officers of health report that they have from time to time been instrumental in discovering the presence of infectious disease both in coastwise vessels and foreign traders, Dr. Collingridge citing 40 instances in which small-pox has been detected on board vessels in dock or at anchor during the last 5½ years, the disease in 30 instances having been contracted in London; the probability is that, but for these timely detections, it would have been carried to other ports.

The coastwise vessels are free to go from port to port unchallenged as to health, and thus have opportunity of spreading disease, but the extent to which it has been transmitted through their agency cannot be determined, the reports of the medical officers of health being, as a rule, *indefinite* on the subject. Thus, the late medical officer of health of the Port of London states that small-pox has *frequently* been introduced into the metropolis by coasting vessels. Dr. Taylor, that typhus fever has from *time to time* been brought to Liverpool from Ireland. He mentions a case of a sailor belonging to a vessel from Waterford walking up to the hospital two or three days after his arrival in port with eruption of small-pox out upon him.

Again, the medical officer of health of Newcastle reports two instances in 1881 in which small-pox was detected in vessels from London. One was that of a mate discovered to be suffering from small-pox two or

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three days after arrival, and upon inquiry it transpired that when he left home some members of his family were ill with the decease.

The clerk to the same authority represents the frequency of the danger to which the people living on the thickly populated banks of the Tyne are exposed through the landing on their shores of infected persons from coasting vessels.

Where vessels are known to have come from infected ports certain of the medical officers of health endeavour to arrange for their early inspection; they find, however, much difficulty in acquiring information on this point, certain ports only being included in the Registrar General's weekly returns of mortality.

Here I would remark that, if the Government could see their way to securing the registration of communicable disease, it would prove a very useful measure, Scotland and Ireland being included therein; and would be specially valuable if the particulars were collected and published by the central authority. Further, infectious disease being the universal enemy of mankind, all peoples might here meet on neutral ground to do battle against its progress, and in this sense if a mutual understanding could be arrived at with foreign Powers for the interchange of information respecting the presence of infectious disease, it would go far to insure a successful issue, the old proverb "to be forewarned is to be forearmed" being specially applicable to disease prevention.

Infectious disease escaping notice of customs house officer.

With regard to the detection of infectious disease on board foreign traders:—It appears that this from time to time occurs in vessels that have been passed by the custom house officer, the presence of the disease escaping his inquiry.

Dr. Collingridge mentions nine instances of the kind, viz., six in respect of small-pox, one of scarlatina, and two of typhoid fever.

Dr. Taylor, two instances of small-pox, one of scarlatina, and one of typhoid fever.

Dr. Armstrong of Newcastle, the detection of a case of typhoid fever and a case of small-pox, the former having escaped the custom house officer through the captain's mistaking it for a simple cold; the latter case through wilful misrepresentation of the captain, for which he was prosecuted and fined 20*l*.

These examples tend to confirm the view expressed in a former part of this report (page 164), that the system of custom house inquiry is not of the best nature to detect the presence of infectious disease. And, moreover, where it is effectual to this end there is often much delay before the medical officer of health can be communicated with, and the necessary steps taken to secure the isolation of the sufferers who in the meantime are occasionally landed, to wit, the case of scarlatina from the "Scythia" already quoted on page 186. Dr. Collingridge also records another instance in which a case of scarlatina reported to him by the custom house officer had landed before the sanitary officer got on board; and, referring to the difficulty he experiences in dealing with such cases, he states that he made arrangements for the cases to be reported to the medical officer on board the hospital ship "Rhin," so as to enable immediate action to be taken, but this apparently does not work well, as the vessels, instead of waiting for the sanitary officer to come on board, continue their course up the Thames, affording opportunity for communication with other vessels, or perhaps with the shore before any action can be taken in the matter.

Reports of medical officers of health.

From the numerous references made to the reports of certain medical officers of health, it is obvious that they contain much useful information, but I would submit that, with respect to infectious disease, their value

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would be greatly enhanced if the particulars connected with the history of the cases that come under their notice were entered in a tabulated form of uniform character, noting the port sailed from, date of sailing, date of attack, and nature of disease, date of arrival in harbour, and, under the head of remarks, such information as they can glean respecting the origin of the cases.

In devising measures in relation to passenger traffic for the protection of public health, and preservation of the health of the emigrant, it is essential in the interest of commerce that they should be non-obstructive and inexpensive, so as not to hinder trade or impose a burden upon the shipping companies that would weight them in their competition with foreigners, or cause them to raise the passage tariff. At the same time seeing that the shipping companies primarily benefit by the traffic, it is only reasonable that they should be called upon to contribute proportionally to the expense attending the adoption of measures for the protection and preservation of the health of their passengers and crews.

Summary and Recommendations.

In summarily reviewing the results of this inquiry tribute must be paid to the various shipping companies by whose enterprise, intelligent forethought, and careful management, the emigration traffic has developed into so gigantic a business. The excellent qualities of the ships employed therein, combined with the punctuality with which the voyages are accomplished, and the liberal treatment accorded to the emigrants, have gained for the several companies a widespread fame securing to them the confidence not only of the British people, but of foreigners, as testified by the numbers that annually come over to this country to re-embark for other lands. As further conducing to this result the various provisions of the Passengers Acts, that bear upon this subject must not be lost sight of, legislating as they do for the well-being and comfort of the emigrants, and at the same time allowing considerable scope of action to those immediately engaged in the traffic.

But, in spite of all that has been done by the Legislature and the shipping companies to promote the general success of emigration, and in contradistinction to the well-organised arrangements that characterise the emigration traffic generally, this inquiry shows that matters relating to disease prevention are carried out in an unsatisfactory fashion, with the result that infectious disease in one form or another is liable to mark the track of emigrants from port to port of this country, and to be frequently carried by them on board ship to the imminent risk of other passengers.

Except by certain of the Colonial Governments, no steps are taken to insure intending emigrants being free of infectious disease when engaging their passage. The advantage of this precautionary measure as well as of the depôt system in comparison with emigrant lodging-houses, is shown by the comparatively small amount of infectious sickness occurring at the depôt and on board the ships chartered by the Colonial Governments.

Certain of the shipping companies provide for the medical examination of emigrants at the lodging-houses. And when they are on the point of leaving the country, then, in accordance with the provisions of the Passengers Acts, the passengers, if they exceed 50 in number, are required to undergo examination by a medical inspector appointed by the Board of Trade, but that is all.

Persons who have come from the continent of Europe for the purpose of emigrating in English ships are not examined as to their health

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at the time of their arrival in England. The administrative department especially entrusted with the care of the public health is in the anomalous position of having no concern with infectious disease in any such person at the moment of its introduction; this duty devolving instead upon officers appointed by the Board of Customs, whose inquiries, though not of the best nature to detect the presence of infectious disease, leave the passenger who has once passed them free to land on our shores and to travel at will through the country to his final port of embarkation, without being subjected to any medical inspection until he is about to depart.

In the event of infectious sickness appearing amongst intending emigrants, it becomes the duty of the local sanitary authority of the district where they may find themselves at the time, to employ the powers vested in them by the Legislature for the prevention of the spread of disease. In districts most likely to be thus invaded the authorities commonly recognise the obligations and responsibilities imposed upon them, and are careful to provide infectious hospitals, to secure the good order, cleansing, and wholesome condition of lodging-houses, and generally to put the law in motion where infringement of the same is brought under their notice. The Public Health Act, however, gives no power to deal with cases of an indeterminate character and an intending emigrant with symptoms of impending attack of small-pox or other infectious disease, would still be at liberty to travel in company with other emigrants, stay at lodgings with them, or go about the district at pleasure, and the authority would be powerless to interfere with his movements until the disease had actually declared itself. In the case of the emigrant, it would seem possible to limit the opportunity of distributing infection from these undeveloped cases.

To return to the Board of Trade inspection on departure: Here the provisions of the Passengers Acts empower the medical inspector to deal with cases of suspicion and to order the re-landing of any persons who may present symptoms of infectious disease, and be liable in his opinion to endanger the health of the other passengers. It is shown in this Report that the re-landing of such rejected cases formerly resulted in the spread of disease amongst people on shore, and that arrangements have since been made between the Board of Trade, the local authorities, and shipping companies concerned to prevent a recurrence of the danger. Where rejected cases have been re-landed and sent direct to the infectious hospital, the healthy members of the family have sometimes been included with them, and as a consequence have contracted the disease.*

Infectious sickness carried on board Transatlantic ships has on various occasions spread to some considerable extent amongst the passengers, owing it would seem to the neglect of due precaution in the way of procuring early detection of premonitory symptoms, together with the want of hospital provision ready at command for the timely isolation of the sufferers.

With reference to the maritime intercommunication between home ports, it is shown that there are no regulations in force to insure the crews of coast-wise vessels leaving port in a healthy condition, and no organised arrangements for the detection of infectious disease on board

* The captains of emigrant and other ships going to foreign or colonial ports are required to provide themselves with a bill of health certifying that the port sailed from is free from infectious disease. This document is usually signed by an officer of the Customs who has little or no opportunity of becoming acquainted with the state of health of the port for which he certifies.

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such vessels when they arrive in port. It is found that in certain of the English ports the statutory duties devolving upon the Port Sanitary Authorities are efficiently carried out; that provision is made for the inspection of vessels in harbour; and the satisfactory results of such action is shown by the marked diminution of vessels now reported to be in an insanitary condition compared with the former years. In other ports the duties are very partially fulfilled. In Ireland vessels are suffered to go to and fro without any inspection; whilst in Scotland there are no constituted port sanitary districts.

The whole burden of this inquiry goes to show the necessity for better means of regulating the passenger traffic, with a view to protecting the British public, the emigrants, and other countries against the spread of dangerous infectious disease; while, along with the interests of health, regard is had to other interests concerned in emigration. Sanitary measures must not be vexatious nor burdensome so as to cause delay in the traffic, nor must they unduly weight English shipping companies by compelling them to raise the passenger tariff.

It may be stated that, throughout the inquiry, the officers of the various departments have appeared to be performing the duties entrusted to them according to their several lights, and that they have worked harmoniously as far as arrangement between themselves was concerned; and the failure to secure the desired end has appeared due to the want of a proper organised system, and the health authorities proper having so little to do in the matter. It should be the object of an improved system to secure better medical supervision, and to give to local sanitary authorities their proper responsibility with regard to sick people of the emigrant class.

[The existing sub-division of administration in regard to questions affecting public health militates somewhat against the efficient carrying out of needful measures of disease prevention. From the circumstance of the Public Health Acts of England, Ireland, and Scotland being administered independently of each other, it may chance that infectious disease prevails in one portion of the United Kingdom without coming to the knowledge of the Government of other divisions of the kingdom, as in the recent instance recorded in this report, where typhus fever prevailed at Queenstown for nearly two years, constituting a considerable danger to the home and foreign trade, and the Imperial Government knew nothing about it.

And with this division of health administration must be considered the further subdivision observed at the several ports; where the health of the emigrants is made the subject of official concern of the Custom House authority, the local sanitary authority, and the Board of Trade. The first admits the emigrants into the country, the Board of Trade passes them out of it, while the local authorities are merely called upon to act when made aware of any cases of infectious sickness occurring amongst the emigrants in their passage through the country.

The present divided system, and the want of proper organisation and arrangement for the protection of the health of the public as well as of the emigrants, cannot but be connected with the amount of infectious sickness recorded in this report; as for example in the case of cholera introduced years ago by foreign emigrants into Liverpool, where it spread in the town, and was also carried on board several ships, and spread to their passengers; or, as in the case of relapsing fever in like manner introduced into Liverpool, prevailing there for some two years, and causing 587

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deaths:—while the frequent detection of small-pox, measles, scarlatina, &c. amongst emigrants at the various stages of their progress from port to port in this country testifies to a frequent danger to English public health involved in the present emigration traffic—a danger which might be materially reduced if a better system were adopted.]

Recommendations.

In the following recommendations, the foregoing considerations have been held in view:—

(1.) *As to intending emigrants:—*

It is desirable that (*a*) shipping agents should be instructed to inquire carefully as to the health of intending emigrants and their families with regard to freedom from dangerous infectious disease (small-pox, measles scarlatina, diphtheria, whooping-cough, typhus, typhoid fever, cholera, erysipelas, chicken-pox). Also, as to whether they have been vaccinated, re-vaccinated, or had small-pox. The form of inquiry should be incorporated on the contract ticket, so as to remove it from the sphere of chance. (*b.*) The shipping companies should instruct their agents to keep themselves acquainted with the health of the districts in which they reside, and to report to the companies the prevalence of any infectious disease. (*c.*) The agents should impress upon the emigrants the importance of avoiding any exposure of themselves to infection after engaging their passage; should advise them as to the best lodgings to go to at the ports of embarkation; and should use their best endeavours to prevent the bringing on board of ships any bedding or other articles that may have been exposed to infection.

There would, however, be considerable advantage if inquiries of the above sort were made, and needful action taken upon them, and if also the requisite medical supervision and examination of emigrants were ordered, by a single Authority; instead of being divided, as at present, between officers responsible to shipping companies, to the Board of Trade, and to the local sanitary authority; and there would be certain further advantages if the emigration health authority of each port could be in relation with the authorities of other ports. Experience will show whether some other functions in regard of the health of shipping while out of port would not naturally devolve upon the same health authority.

(2.) *As to medical inspection of emigrants:—*

(*a.*) On arrival in the United Kingdom from the Continent of Europe emigrants on their way to America and elsewhere should be subjected to efficient medical inspection in a duly appointed place suitable for the purpose.

(*b.*) All emigrants should be placed under systematic medical supervision during their stay in lodgings pending embarkation, with a view to the immediate detection of any symptoms of infectious disease among them.

(*c.*) The final inspection of emigrants before embarkation should be made by the same medical officer who has been entrusted with the supervision of them in lodgings, and such inspection should take place under favourable circumstances as regards light, space, shelter, and freedom from confusion.

(*d.*) These inspections should include all emigrants whether in short ships or otherwise.

(*e.*) Emigrants detained at ports of debarkation, or in any lodging-house or depôt, or removed from ships on account of suspected infection,

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should be kept under observation with proper precautions respecting them, until the nature of the disease is declared.

(3.) *As to lodging-houses :—*

The depôt system offers such considerable advantages that it is desirable it should be generally adopted. At the same time there are undoubtedly practical difficulties in the way of carrying this out, such as the fluctuating character of the trade, the immense number of passengers, and the number of shipping companies engaged. Still, I think it feasible, and an effort should be made to bring it about. But whether the depôt system be adopted or not every emigrant lodging-house should be provided with rooms, in which cases of illness suspected to be of an infectious nature can at once be isolated; and scrupulous care should be taken to insure all such houses being kept in a thoroughly sanitary condition.

(4.) *As to precautionary measures on board ship :—*

It is important (*a*) that infectious hospitals should be provided on the weather deck in the least frequented part of the ship.

(*b.*) That the surgeons should be instructed to make daily inspection of emigrants during the voyage, and to secure the immediate isolation of cases presenting suspicious symptoms.

(*c.*) That record should be kept of the particulars of all cases of infectious disease that come under treatment, including any deaths that may occur during the voyage.

(*d.*) That immigrants, *i.e.*, persons embarking for the United Kingdom, should be subjected to medical inspection by the surgeon of the ship at the time of embarkation.

(5.) *As to cattle ships :—*

A week at least should elapse between the landing of cattle from a ship, and the use of the ship for emigrants. The ship meanwhile should be thoroughly cleansed to the satisfaction of the port sanitary authority.

(6.) *As to ships' crews :—*

Shipping companies should take steps to secure the re-vaccination of their officers and men, making it a condition of service. The surgeons of the ships should be required to make special report to the shipping companies as to compliance with this regulation.

(7.) *As to coastwise vessels :—*

Steps should be taken to insure coastwise vessels leaving port free of infectious disease, and to establish a uniform system of inspection of vessels in harbour throughout the United Kingdom to insure their being kept in a wholesome condition.

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No. 15.

MEMORANDA, prepared with the assistance of Dr. PARSONS, on the CIRCUMSTANCES under which the CLOSING of PUBLIC ELEMENTARY SCHOOLS or the EXCLUSION therefrom of particular CHILDREN may be required in order to prevent the SPREAD of DISEASE.

1. It is attempted in these notes to bring together the information in the possession of the Local Government Board, derived from the reports of the Board's own Medical Inspectors and of local Medical Officers of Health, respecting school-closure and exclusion from school as precautions against infection. It is sought to indicate the best means of preventing the spread of disease by school children among their fellows, while avoiding any unnecessary interruption of the work of education.

2. In the Code of Regulations approved by the Lords of the Committee of Council on Education on the 6th March 1882, the following Article (Art. 98) prescribes as one of the general conditions required to be fulfilled by a Public Elementary School in order to obtain an annual Parliamentary grant, that

"The Managers must comply with any notice of the sanitary authority of the district in which the school is situated, requiring them for a specified time, with a view to preventing the spread of disease, either to close the school or to exclude any scholars from attendance, subject to an appeal to the Department, if the managers consider the notice to be unreasonable."

To facilitate compliance with this Article, certain other provisions are made (Arts. 94, 95, 102).

Article (96 (*a*)) is also of importance in connexion with questions of disease prevention.

The Education Department must be satisfied "that the school "premises are healthy, well lighted, warmed, drained, and ventilated, "properly furnished and supplied with suitable offices, and contain "sufficient accommodation for the scholars attending the school.

"N.B.—In administering this article the Department will endeavour to secure at least 80 cubic feet of internal space and 8 square feet of internal area for each unit of average attendance; . . . . ."

3. The diseases for the prevention of which school closure, or the exclusion of particular children, will be required are principally those which spread by infection directly from person to person, such as scarlet fever, measles, diphtheria, whooping-cough, small-pox, and rötheln, the order in which the several diseases are here given being about that of the relative frequency with which their occurrence gives rise to these questions at schools. More rarely, the same questions arise in connexion with enteric fever and diarrhœal diseases which spread not so much by direct infection from person to person as indirectly through the agency of local unsanitary conditions, such as infected school privies.

A further and peculiar relation between school and infection is suggested by Mr. Power's recent report on diphtheria at Pirbright (see page 52 of the present volume) but this does not need consideration for the immediate purposes of these memoranda.

4. It will be seen that Article 98 quoted above confers upon sanitary authorities an alternative power with respect to public elementary schools,

(*a*.) To require the school to be closed for a specified time, or

(*b*.) To cause particular scholars to be for a specified time excluded from attendance.

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[illegible] to consider the circumstances under which the requirements of the public health for preventing the spread of disease will be satisfied by the less severe measure of the *exclusion from* school of particular children.

It may be laid down as a universal principle that all children suffering from any dangerous infectious disorder (*i.e.* of a nature dangerous to some of the persons attacked by it, however mild in other cases) should be excluded from school until there is reason to believe that they have ceased to be in an infectious condition (see Section 126 of the Public Health Act, 1875).

Furthermore, as it is always possible to provide effectual isolation of the sick from the healthy within the homes of children of the class attending public elementary schools, it must commonly be necessary that all children of an infected household should be excluded from school; first, because otherwise such children might attend school while suffering from the disease in a more firm, or in an unrecognised stage, and, secondly, because it is known that infection may attach itself to, and be conveyed by, the clothes of a person living in an infected atmosphere, even though the person himself remain unaffected. The same considerations will sometimes make it desirable to prohibit the attendance at school of all children from a particular street or hamlet.

In the case of infectious diseases involving little or no danger to life, such as mumps or skin diseases, school interests may be more particularly considered in determining the exclusion of scholars. In such case, however, the rule of prohibiting the attendance of every child while in an infectious state will commonly prove to be the right one; for if disease should spread to other scholars owing to the continuance of an infected child at the school, there will be greater ultimate loss of attendance with corresponding loss of credit to the school.

6. The Medical Officer of Health, on becoming aware of the presence of dangerous infectious disease in his district, should send immediate notice to the teacher of the school or schools which the children of infected households may be attending, requesting that such children may be excluded from school for such time as he (the Medical Officer of Health) may specify as being necessary. (*See* Articles 2 (7) and 18 (6) of the Board's General Orders prescribing the duties of Medical Officers of Health).

Frequently, the school attendance officer or the schoolmaster himself will obtain the earliest information of the occurrence of infectious disease among scholars, and it is most desirable that such officer or master should without delay communicate the facts to the medical officer of health. Absence of any child from school on the plea that it is suffering under one of the before-mentioned diseases, and absence of several children of one family from school at the same time, no matter what name be given to the complaint that keeps them at home, should be reported to the health officer. In practice it has been found that this notification of absentees has materially aided the local health officer in taking measures for the suppression of infectious disease, to the advantage alike of the district and of the school. Furthermore, schoolmasters may properly be asked to take note, especially when an epidemic threatens or is present, of symptoms occurring in any of their scholars that may indicate the commencement of disease, febrile in nature. Such symptoms are shivering, headache, and languor, especially if commencing suddenly, vomiting, rashes on the skin, and sore throat.

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When scarlet fever or diphtheria is about, every trace of sore throat should be looked upon as suspicious. In any case where such symptoms are observed, the safest course will be to exclude the child from school until assurance can be had that it may attend school without harm to itself or danger to other scholars.

7. The time to be specified, during which the exclusion from school of particular children is to last, will vary in different diseases and different cases, and in this matter the sanitary authority will doubtless be guided by the advice of their Medical Officer of Health, who may properly be entrusted with some general duty of acting for the authority in this subject-matter.

Medical officers of health, having to specify a time during which any scholars are to be excluded from attendance at any school, should have regard as far as practicable to the circumstances of the particular scholars suffering from infectious disease or living in infected households. Not only the nature of the infection and the length of illness, but the environments of the individual as affecting the retention of infection will deserve consideration. The period of exclusion for example will need to be different according to the conditions of a patient's lodgment, according to the sufficiency of the separation that can be effected between a patient and excluded scholars, and according to the opportunities of effectual disinfection that can be afforded to the household. Thus a hard-and-fast rule, such as has been laid down in some districts where scarlatina has been present, that no child shall go to school from an infected house for three months after the disease has begun in that house, is not to be commended. It is indeed possible that under the circumstances of a particular household, a child convalescent from scarlatina or living in the same house with convalescents should not in the interests of other children be permitted to return to school until after so long a period as this; but the same ought not to be assumed of all households in the district that may be invaded by scarlatina. The better plan would be for the sanitary authority to secure, during a shorter period, the exclusion of individual sick persons and their housemates from school; and when that period is about to expire to cause fresh inquiry to be made as to the expediency of further exclusion and, if found requisite in particular cases, to cause fresh notice to be given to the school managers.

8. *Secondly*, as to the *closing of schools*. This, by more seriously interfering with the educational work of a district, is a much more grave step for a sanitary authority to take than to direct the exclusion of particular scholars. It is a step that seldom ought to be enforced, except in presence of an actual epidemic, nor even then as a matter of routine nor unless there be a clear prospect of preventing the propagation of disease, such as could not be looked for from less comprehensive action.

The mere fact that in an epidemic many of the sufferers are school children does not necessarily show that the disease was caught at school; but the school may with probability be regarded as spreading infection if in a large majority of households attacked the first case be a child attending school; and with still greater probability if a number of children living at a distance from one another, and with no circumstances in common, except that they attend the same school, should be simultaneously attacked, and if it can be ascertained that a child or teacher in an infectious state has actually been attending the school.

9. In deciding whether an outbreak of infectious disease among children of school age may be best combated by closing the school, or

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whether it will suffice to exclude the children of infected households, the two most important points to be considered are :—

(*a.*) The completeness and promptness of the information received by the officers of the sanitary authority respecting the occurrence of infectious cases.

(*b.*) The opportunities which exist for intercourse between the children of different households elsewhere than at school.

10. (*a.*) The more prompt and full the knowledge of cases of infectious disease that the sanitary authority are able to obtain, the better will be the prospect of checking such disease by keeping away from school the children of infected households, and the less will be the necessity for closing schools. If the cases be few in number, and their origin known, the exclusion from school of the children of infected households will probably suffice, but this measure will fail where there are many undiscovered or unrecognised cases, or where the known centres of infection are peculiarly numerous.

Commonly, the failure of carefully considered measures of exclusion to stay the spread of an epidemic which shows a special incidence upon school children, may be regarded as pointing to the continued attendance at school of children with the prevalent disease in a mild or unrecognised form, and a strong case will appear for the closing of schools.

If by reason of the absence or exclusion of a large number of children, the attendance at a school be greatly reduced, it may be found better to close it altogether. This is especially apt to occur in the case of epidemics of measles, a disease which is very infectious in the early stages, before the characteristic rash has appeared, and while the symptoms are only those of a common cold.

> In a village where a medical practitioner purposely concealed the existence of scarlatina among his patients, the exclusion from school of children living in those houses that the sanitary authority knew to be infected failed to check the prevalence of the disease, but it began to decline as soon as the schools were closed.

11. (*b.*) The second material consideration, in deciding as to the desirability of closing schools during the prevalence of infectious disease, is the amount of opportunity for intercommunication between the members of different households elsewhere than at school. In sparsely populated rural districts, where the children of different households, or of separate hamlets rarely meet except at, or on their way to, the village school, the closing of the school is likely to be effectual in checking the spread of disease. It is less likely to be useful in a town or compact village (particularly where houses are sub-let and yards are in common), where the children of different households, when not at school, spend their time in playing together, and often run in and out of each other's houses. In some such places the closing of schools has even appeared to do harm rather than good.

In rural districts, where epidemic diseases are less frequently prevalent, school managers may more fairly be asked to close their schools; as an exceptional measure to meet an exceptional state of things. As regards more populous places, it must not be forgotten that if schools were to be closed whenever an infectious disease was prevalent, there are many places where schools would hardly ever be open.

12. It will sometimes be necessary to close a school for a day or two to allow of the rectification of sanitary defects of a nature to extend disease, or in order that the school may be disinfected or purified. It has happened that infectious sickness in the master's family has forbidden the attendance of scholars. These more temporary and

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occasional closures of schools are contemplated in the before-quoted section of the Education Code, and are to be regarded as having a real importance of their own.

Formal processes of cleansing and disinfection will be especially wanted if children in an infectious condition have actually been attending school. It is to be desired that the details of them should be defined by the Medical Officer of Health, at whose instance they are taken, and that they should be executed to his satisfaction.

As a precautionary measure, during the prevalence of an epidemic the fumigation of the schoolroom every week by burning sulphur may be recommended, and may usually be done on Saturdays without interruption of school duties.

As regards enteric fever and other diseases attended with diarrhœa, it is not to be forgotten that such diseases can spread through school privies that have become infected by the discharges of a commencing or unrecognized case. When such diseases are prevalent, school privies should be frequently emptied and cleansed, and such disinfectant as the Medical Officer of Health may advise should be applied to them according to his instructions and in liberal quantity.

The sanitary defects of schools, likely to assist in the propagation of disease, are most usually found to be uncleanly condition, want of ventilation, untrapped waste pipes from lavatories, bad construction, bad position, or foul condition of closets. Ventilation is a matter so important in the present connexion that it may be well to note here that every schoolroom should be adequately furnished with means of ventilation of two kinds, viz., (*a*) apertures for the supply, during school time, of a steady volume of air without draughts; and (*b*) windows made to open on two sides of the room so that the whole aërial contents of the room may be thoroughly changed in the intervals between school hours.

The principles to be held in view in the construction of school privies are set forth in a memorandum, prepared in this department for the use of the Committee of Council on Education, entitled, "Practical Suggestions as to the Construction and Cleansing of School Offices."

A supply of wholesome water should be secured to every school. Epidemics at schools have been traced to the drinking of contaminated water furnished from school wells or obtained from neighbouring sources.

In places where children have to come from a distance, and do not go home for their midday meal, a room should be open for their use during the interval between morning and afternoon school, or they will seek shelter where they can,—perhaps in infected houses.

13. In places where there are several public elementary schools, if an outbreak of infectious disease be confined to the scholars of one particular school, it may be sufficient to close that school only. But where different schools have all appeared to aid in the spread of disease (though perhaps to an unequal extent) the sanitary authority may consider it advisable that all should be closed, not only for the sake of appearing to deal with all impartially, but also lest children in an infectious state who previously attended the schools that are closed, should be sent to others that might remain open.

It must be remembered that sanitary authorities have no power in respect of Sunday schools, or dames' or other private schools: except in so far as these may contravene sect. 91 (5.), sect. 126

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or other provision of the Public Health Act; and the closing of Public Elementary Schools may tend to undue crowding in dames' schools.

14. Notices of the sanitary authority for the closing of Public Elementary Schools should be made in writing to the managers, and should state the grounds on which the closing is deemed necessary.

All such notices should specify a definite time during which the school is to remain closed; this should be as short a period as can be regarded as sufficing on sanitary grounds; a second notice may be given before the expiration of the first, if it should be found necessary to postpone the re-opening of a school. The managers of schools have an appeal to the Education Department, if they consider any notice to be unreasonable.

15. In conclusion two general observations may be made.

First, that in proportion as the sanitary authority have performed their own proper work for the protection of their district from infectious diseases,—as they have secured early information of the occurrence of cases; as they have provided accommodation for the isolation of such cases; and arranged for keeping patients under supervision until their infectious condition has ceased; and as they have provided for the subsequent disinfection of infected houses and things,—the more successfully will they be able to deal with such diseases when they occur, without the serious interference with the business of popular education involved in the compulsory closing of schools.

Secondly, that the proper work of schools is facilitated and the credit of the school is promoted by every measure which hinders the spread of infection. Wherefore it is entirely in the interests of school managers themselves to trust the skilled judgment of sanitary authorities, and to aid their endeavours to maintain the public health.

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APPENDIX B.

No. 1.

FURTHER REPORT on the RELATION of PATHOGENIC to SEPTIC BACTERIA as illustrated by OBSERVATIONS on BACILLUS ANTHRACIS; by E. KLEIN, M.D., F.R.S.

In my Report for 1881 I have pointed out, that artificial cultivations of bacillus anthracis, not containing any spores, after from several days to a few weeks lose the power to infect white mice with anthrax, but retain their full power on guinea-pigs and rabbits. And this power on the last-named animals is retained as long as there exist in the culture living non-degenerated bacilli. The white mice not affected by such cultivations, as I have also pointed out, have no general refractory power against anthrax or bacillus anthracis, and do not obtain by these unsuccessful inoculations any kind of immunity against active cultures.

These results were not quite in accordance with the general statements of M. Pasteur.

I was anxious to test these cultivations on sheep, knowing from M. Pasteur's observations that his artificial cultivations leave sheep without disease but with immunity, and it seemed to me desirable to ascertain whether the above cultivations were effective in the sheep, or whether they were without result on that animal, as they are on white mice.

On April 19th I inoculated one healthy sheep (No. 1) with a few drops of an artificial cultivation (the fifth transfer from mouse's blood bacillus) of bacillus anthracis in fluid alkaline pork broth. This cultivation had been established on April 8, and was used on April 17 for two white mice and one guinea-pig.

The guinea-pig was dead within 48 hours, the mice remained well and lively.*

The cultivation when used contained numbers of isolated bacilli, and of threads of them, many showing the process of degeneration described in my former Report, *i.e.*, granular degeneration and dissolution; others were, however, perfect.

The sheep remained perfectly well. Its temperature remained normal, it fed well, and was otherwise quite healthy.

After the lapse of two days it was inoculated again with the same cultivation. At the same time two guinea-pigs were inoculated with it. The sheep received about half a Pravaz syringe, the guinea-pigs only a few drops.

The guinea-pigs remained perfectly well for the next eight days. The sheep, however, showed a tremendous rise of temperature, from 39°·2 C. to 41°·6 C. on the third day after the fresh inoculation; in the evening of the third day the temperature rose to 42°·2. On the fourth day it fell to 41°·4 in the morning, then to 40°·4 in the evening; on the fifth day it fell further in the morning to 40°·2; but rose again in the evening to 41°·4. On the sixth day it was at 41° in the morning, at 42·2° in the evening. The animal died in the night.

It fed tolerably well till the sixth day, when it ceased to ruminate. But it was always dull while the temperature was above 40°.

* The fluid is introduced by means of a capillary pipette far into the subcutaneous tissue of the groin, in the same manner that I generally use, and as has been mentioned in my first Report (Report of Medical Officers to Local Government Board for 1881, p. 191).

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P.M.—Liver excessively pale, firm, and small; shows distinct chronic cirrhosis. Spleen small, very brittle. Lungs much inflamed, numerous minute extravasations on the pleura. Examining the spleen under the microscope, it is found to contain vast numbers of bacilli anthracis, some of unusual length, being long threads, such as are only known to occur in artificial cultivations. They were aggregated in convolutions in the splenic vessels.

This condition of the bacilli is, I presume, explained by the fact that the disease lasted comparatively long (six days being an unusually long time), and therefore the bacilli had time to form the threads. It is an extraordinary fact that the spleen did not show conspicuous enlargement. The blood of this sheep contained numerous bacilli anthracis. Inoculated with it one guinea-pig. This animal was found dead of typical anthrax on the fifth day.

[An interesting fact is brought out by this series of experiments. It is this: the cultivation used for the inoculation of the sheep and for that of two guinea-pigs contained, as was stated above, a great many bacilli in a state of degeneration, and consequently when used in a small quantity, the chances are that the result will be negative; such was the case in the first inoculation of the sheep and in the inoculation of the two last guinea-pigs. But when using larger quantities, the chance of escape from the good or perfect bacilli was small or nil, and such was the case in the second inoculation of the sheep. These facts are in complete harmony with the observations described in my first Report, p. 199.*]

The sheep being unaffected by the cultivation in the first instance, but affected fatally by the same cultivation in the second inoculation, sets aside, of course, the question of any immunity that might have been supposed to have been conferred on it by the first inoculation.

Inoculated a second healthy sheep (No. II.) on May 8 with an artificial cultivation of bacillus anthracis (first remove from guinea-pigs' blood) established on April 13, *i.e.*, 25 days old. This cultivation had lost by this time its power to affect white mice, but proved fatal to guinea-pigs, as was ascertained by direct experiment.

On May 10 the sheep is ill, temperature 41° C.; the animal does not feed well, does not ruminate either; respiration laboured. Examined the blood, but found no bacilli in it.

On May 11 the animal seems a little better, feeds and ruminates, but temperature is high, 41° C. Examined the blood, but found no bacilli in it.

The animal died in the evening of May 11. Typical anthrax was found at the post-mortem examination.

In these two cases, then, we have proof that a cultivation that had lost its effect on white mice, nevertheless possesses fatal action on sheep in the same way as on guinea-pigs.

The next question I asked myself was this: is it generally true, as M. Pasteur says, that bacillus anthracis growing at 42° C. loses its virulent effect?

From a 17th cultivation of bacillus anthracis originally derived from guinea-pig dead of inoculated anthrax, I established on May 24 two cultivations in neutral fluid pork broth, one was kept at 42° C., the other

* In the case of the two guinea-pigs the inoculation was effected with the same cultivation as in the first guinea-pig, but with this difference, that it was two days older; and according to repeated observation such a short time does not make any experimentally appreciable difference in the virulence of a cultivation on guinea-pigs, other things being the same.

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at 22° C. According to M. Pasteur's statements the fluid that had grown at a temperature of 42° C. ought to have had no fatal effect; it, nevertheless, proved to be very virulent when inoculated into guinea-pigs and mice, while the other, grown at 22° C., did not prove fatal when used after some time on white mice.

The results of the experiments with these two fluids are very striking, and illustrate in a very marked manner the erroneousness of M. Pasteur's general statement.

Three white mice were inoculated with the above cultivation that had been grown for nine days at a temperature of 42° C. All three died of typical anthrax: two after three days, the third after five days.

With the other cultivation, established in the same way and at the same time as the above, but kept for the same period at 22° C., inoculated in exactly the same manner as the above mice three other white mice. These remained perfectly well.

It has, however, occurred to me to have cultivations of bacillus anthracis grown at 42° C. which had no effect on guinea-pigs; these cultivations were made of anthrax blood of sheep, were kept at 42°–43° C. for 15 days, and when inoculated into two guinea-pigs proved without the slightest effect. In this case I could not start a new cultivation with that culture, and the microscopical examination revealed only the presence of granular matter and of multitudes of degenerated threads of bacillus anthracis. The two guinea-pigs were subsequently inoculated with some active cultivation and succumbed promptly with typical anthrax. These observations are in harmony with the observations of my former Report with reference to the loss of activity of a culture due to progressive degeneration of the bacilli.

So much for guinea-pigs and mice; but how do sheep behave towards a cultivation of bacillus anthracis grown at 42° C.?

The same cultivation as used above (*i.e.*, that grown at 42° C.) was inoculated on June 23 into two healthy sheep, III. and IV.

At the same time two other sheep, V. and VI., were inoculated with the cultivation grown at 22° C. as above; and for the sake of further comparison two sheep, VII. and VIII., were inoculated with blood of spleen of a mouse that had died of (inoculated) anthrax. This blood was full of the bacillus anthracis.

All six sheep showed febrile rise of temperature and constitutional disturbance.*

The temperature of these animals before experiment ( ), and on the evening of the several days after experiment, was as follows:—

Sheep No. III.	(39°·0)	June 23	39·4
		„ 24	39·6
		„ 25	41·
Sheep No. IV.	(39°·2)	June 23	39·8
		„ 24	39·8
		„ 25	41·6
		„ 26	41·8
Sheep No. V.	(39°·2)	June 23	39·4
		„ 24	39·8
		„ 25	40·2

* These and some of the further experiments on sheep were made at my suggestion and under my direction by Professor Roy and Mr. Batt at the Brown Institution.

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Sheep No. VI. (40°·0)	June 23	40·2
	„ 24	41·2
	„ 25	41·
	„ 26	40·2
Sheep No. VII. (39°·4)	June 23	39·2
	„ 24	39·8
	„ 25	40·
	„ 26	40·4
Sheep No. VIII. (39°·8)	June 23	39·4
	„ 24	40·6
	„ 25	39·6
	„ 26	39·6

Of these sheep No. III. died on June 26, *i.e.* after three days; No. IV. died on June 28, *i.e.* after five days. In both instances the post-mortem examination showed typical anthrax.

In both instances there was slight œdema at the seat of the inoculation. The internal organs showed the typical appearances of anthrax. Spleen of No. III. was enlarged and full of bacilli, but the spleen of No. IV. contained only very few bacilli.

Sheep No. V. died on June 26, *i.e.*, after three days, but sheep No. VI. recovered completely.

Sheep No. VII. and VIII. recovered completely.

Thus we see that while both sheep inoculated with cultivated bacillus anthracis grown at 42° C. succumbed, only one died after the inoculation with cultivated bacillus anthracis grown at 22° C., whereas both sheep inoculated with mouse's blood (anthrax) recovered.

The three sheep Nos. VI., VII., and VIII., having had rise of temperature and constitutional disturbance in consequence of the inoculation, were now used to test the question, whether they were immune against further inoculation with virulent material. Consequently the following inoculations were performed on July 1 :—

Sheep No. VI. was inoculated again with the same cultivation as was used to it the first time, *i.e.*, grown at 22° C.

Sheep No. VII. and VIII. were inoculated with blood full of bacillus anthracis of a guinea-pig that had died of anthrax.

They remained all right until July 13.

They were then again inoculated with virulent spores of bacillus anthracis; one guinea-pig inoculated at the same time. The guinea-pig was dead within 48 hours; the sheep remained well. The three sheep were again inoculated on July 26 with bacillus anthracis of spleen of sheep dead of inoculated anthrax (*see* below). They remained well. They were again inoculated on October 4, but remained well.

The fact that the two sheep (VII. and VIII.) withstood the effect of the first inoculation with anthrax bacillus of blood of mouse suggested the possibility that sheep as a rule might not be fatally affected by blood of mouse or guinea-pig, but that in the event of their showing sufficient constitutional disturbance might be hereby made immune against further attack by anthrax. Consequently the following experiments were made :—

Two healthy sheep, IX. and X., were inoculated on July 24 with blood of spleen of a guinea-pig dead of anthrax. Both animals were

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dead in the night of July 25. The post-mortem examination showed typical anthrax. Spleen much enlarged and full of bacilli anthracis.*

Thus, hereby, the question of the fatal effect of guinea-pig's anthrax blood was settled. Now, how about mouse's anthrax blood? To solve this question the following experiments were made:—

Sheep Nos. XI., XII., and XIII. were inoculated on October 14 with fresh blood of a mouse dead of anthrax for a few hours. They showed rise of temperature for the following three days, but always fed well and ruminated. They had quite recovered on October 18.

On November 2 inoculated the same three sheep and a guinea-pig with spore-containing cultivation of bacillus anthracis; the guinea-pig was dead after three days of typical anthrax. The sheep remained well.

Thus we see that mouse's anthrax blood while affecting constitutionally the sheep did not produce fatal effect and at the same time furnished them with immunity against further inoculation with virulent material.

The experiments detailed in the preceding made it desirable to ascertain the precise manner in which Pasteur's "vaccin" operated on the various animals. Since I have not been able to obtain by cultivation of the bacillus anthracis at 42°–43° C. as stated by Pasteur, a fluid that possesses the character of a vaccine, and since M. Pasteur has not published the details of the method by which he obtained his vaccine, and further, since several of his statements could not be substantiated, I began, not of course to doubt the accuracy of his account and result of vaccination with vaccin charbonneux of sheep and cattle in France and elsewhere, but to question his statement as to the universal applicability of his results, and as to the effects of his vaccine in protecting other animals.

I proceed now to describe the experiments which I made with M. Pasteur's "vaccin charbonneux," that is to say, cultivations of bacillus anthracis made in M. Pasteur's laboratory, and which cultures are said to have the power to affect the animals inoculated with them in a manner that would make them only imperceptibly ill, but nevertheless, would give them immunity against further inoculations with any—the most virulent—anthrax material. As is well known, this "vaccin charbonneux" is manufactured in large quantities in the laboratory of M. Pasteur, and is sold by his agent, M. Boutroux, in Paris. It is sold for 20 francs per two tubes "vaccin premier" and "vaccin deuxième," each containing a clear fluid with a minute quantity of a powdery precipitate; the fluid is said to be sufficient for the inoculation of 100 sheep or 50 cattle. According to the printed directions, the premier vaccin is inoculated first, after the lapse of about a fortnight the deuxième vaccin is used, and then the animals are supposed to be immune against any further inoculation with anthrax. No constitutional disturbance is said to be observable in the animals during or after the experiment.

I obtained, through M. Boutroux, two lots of this "vaccin," each lot consisting of a tube of premier and deuxième vaccin, and I at once started a series of experiments with it.

From M. Pasteur's address before the International Medical Congress in London 1881, reprinted from the Transactions of the International Medical Congress Vol. I., and circulated at the instance of the Local Government Board, and from M. Pasteur's statements in other places,

* These experiments were also made at my suggestion by Professor Roy and Mr. Batt.

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everyone had understood that this "vaccin charbonneux" knows no difference of species, breed, or country; that it confers its salutary powers on all alike.

I now proceed to give here the details of my experiments, and the reader will be able to judge for himself whether some limitations to this general belief are not required.

First Lot.—On July 17, opened a tube of premier vaccin, and inoculated with its fluid:—

(*a.*) Two guinea-pigs.
(*b.*) Two healthy sheep, Nos. XIV. and XV.
(*c.*) Five mice.

The animals showed no change, except one mouse that was found dead on July 28 of anthrax.

On July 29 opened a tube of deuxième vaccin and inoculated with it:—

(*a.*) The two guinea-pigs as above, and
(*b.*) The two sheep, Nos. XIV. and XV.

The two guinea-pigs were dead on August 1 of typical anthrax. The premier vaccin had not availed to save them from death by the deuxième vaccin.

With blood of spleen of one of these guinea-pigs, inoculated the four mice (*c*) left of premier vaccin.

These four mice were dead within 48 hours of typical anthrax, so that those which escaped death by the premier vaccin did not receive from it any immunity against the active material of anthrax.

The two sheep showed slight rise in temperature but soon recovered.

These two sheep were inoculated on August 5 with cultivations of bacillus anthracis grown at 42° C. for about 21 days. There were present in this culture large numbers of degenerated bacillus threads, but also some few good bacilli.

[Inoculated at the same time with very minute quantity of it one guinea-pig. This guinea-pig showed on August 7 slight œdema at seat of inoculation, but otherwise seemed all right. Inoculated it again with same material. It was dead with typical anthrax within 48 hours.]

The two sheep showed on August 7 rise of temperature, much swelling and œdema about the place of inoculation. Next day, *i.e.*, August 8, they were found dead of typical anthrax.

We see, then, further that also sheep, although they were slightly affected by the deuxième vaccin, succumbed to the inoculation with a culture grown at 42° C.; that is to say, not only were they not made immune by the inoculation with Pasteur's two vaccines, but they were killed by a culture which, having been grown at 42° C., ought, according to Pasteur, to be ineffectual to kill an ordinary sheep not specially prepared by his vaccin charbonneux.

This represents the first series of experiments undertaken to test Pasteur's general statements with reference to the vaccin charbonneux.

Second lot of the vaccin charbonneux. I then commenced experimenting with this as follows:—

Inoculated with fresh vaccin premier*:—

(*a.*) Nine guinea-pigs.
(*b.*) Six mice.

* It is very remarkable that those inoculated at the same time, the same place, in the same manner, with about the same quantity of precisely the same material, died at periods so very different.

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Of these mice five died of typical anthrax :—
One after two days.
One after three days.
One after five days.
Two after six days.

Of the guinea-pigs, six died after three days, the others remained unaffected.

Opened fresh deuxième vaccin and inoculated with it :—
(*a.*) The three guinea-pigs left of premier vaccin.
(*b.*) The one mouse left of premier vaccin.
(*c.*) Six fresh mice.
(*d.*) Four fresh guinea-pigs.

Of these mice all died of typical anthrax.

Of the guinea-pigs six died; one of the fresh lot (*d*) remained unaffected for three weeks.

This one guinea-pig was then inoculated with an artificial cultivation of bacillus anthracis; it died of typical anthrax after two days.

Having thus tested the efficacy of the vaccin charbonneux,* and having found it altogether different from what it was represented to be by M. Pasteur in his address to the International Medical Congress, I wished to ascertain what this vaccin charbonneux really contained. I therefore made the following experiments :—

Immediately on opening of the premier vaccin charbonneux of the first lot, I withdrew a small quantity and inoculated with a droplet of it (under the same safe conditions that I do successive inoculations of culture fluid) several test tubes with sterilized pork broth, and several flasks with mixture of gelatine and pork broth, as used in my former experiments (see the Report for 1881).

These test tubes and flasks were placed in an incubator, and some were kept at a temperature of 42° C., others at 32° C.

[The vaccin premier was at the same time examined afresh microscopically; it contained very numerous minute bright particles that did not look unlike spores, but most of them were probably mineral particles.]

All test tubes and flasks were found after 24 hours turbid and full of micrococci, in dumbbells and chains. A few days later there appeared in addition thin bacilli, which formed a thick scum on the surface, here were also numerous spores in them. The bacilli did not look at all like anthrax bacilli.

All test tubes (eight in number), and the flasks (three) showed the same appearances, and this of course proves undeniably that these organisms that developed in them were introduced by the vaccin charbonneux, and not by accidental contamination.

My inoculations were done after the same plan that I practised so often before, and that I described on p. 180 of the Reports of Medical Officer for 1881, so that I am quite confident that the above organisms in the cultivations were not introduced accidentally during the process of inoculation. So much for the purity of this vaccin charbonneux.

By inoculating guinea-pigs with these cultures, *absolutely no effect* was produced, nor were these animals made hereby in any way immune against further inoculation with cultures of real anthrax bacillus. Of this I have convinced myself sufficiently to speak with absolute certainty.

* I still now (1883) possess the remains of the vaccin charbonneux employed in the above experiments, and I use it with good results whenever I wish to produce fatal anthrax in rodents.

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I do not mean hereby to say that the vaccin charbonneux did not contain the bacillus anthracis or its spores; on the contrary I knew by experiment, *i.e.*, by the inoculation made with it in mice and guinea-pigs, that this particular vaccine premier did contain them, for I killed several animals with it; but what I mean to say is, that this vaccin charbonneux was contaminated to a large degree with micrococcus and another bacillus.

Inoculated with Pasteur's deuxième vaccin several test tubes with pork broth.

After three days the surface was covered with a thick white scum of a thin bacillus, and bacillus threads, and in them numerous spores.

Inoculated with a considerable quantity of these bacilli two guinea-pigs.

They remained perfectly well. After one week inoculated them again with same material.

They remained perfectly well.

Inoculated them with a cultivation of bacillus anthracis. They were both dead of typical anthrax within three days.

Inoculated with premier vaccin charbonneux of a second lot several test tubes of pork broth.

After two days there was present on the surface a thick white scum of a thin bacillus and its threads, with many spores in them.

Inoculated with considerable quantities of this growth two guinea-pigs. They remained perfectly well. Inoculated them after six days with a culture of bacillus anthracis kept growing at 42–43° C. for 15 days. This culture contained only degenerated threads of bacillus anthracis. This inoculation had absolutely no ill effect on the two animals.

After three weeks inoculated them again with fresh culture of bacillus anthracis. They were both dead of typical anthrax within two days. Thus we see that neither the culture produced with M. Pasteur's vaccin charbonneux, nor a culture of bacillus anthracis produced after M. Pasteur, *i.e.*, grown at 42–43°, had any protective influence on these animals, since they both promptly succumbed to an active culture of bacillus anthracis.

These experiments sufficiently satisfied me that M. Pasteur's assertion, to the effect that a vaccin charbonneux gives again origin to a crop of the mitigated and modified bacillus anthracis, and that animals thus treated are protected against further attack by bacillus anthracis, is not borne out by actual observation.

With regard to the scum-forming bacillus that appeared in the above cultivation, there is every a priori probability of its having no connexion whatever with the bacillus anthracis or its spores present in the vaccin charbonneux with which the cultivation had been inoculated. How can one for a moment suppose that the bacillus anthracis would by a single transfer assume altogether so different morphological characters —greater thinness, formation of scum, &c.—and would at once lose all its physiological power? Even Dr. Hans Buchner, who, as is well known, is very enthusiastic about the change of non-pathogenic into pathogenic bacillus, would consider such a sudden leap as evidence against the transformation.

A question of importance that presented itself several times in the course of this inquiry was this: Is a cultivation in which in course of time the bacillus anthracis, at first forming a copious growth, degenerates and in which no spores had been formed, and further which cultivation loses as we know its power to infect with virulent anthrax animals

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when inoculated, is such a cultivation, I say, perfectly ineffective in giving the animals some sort of immunity against further inoculation with virulent material? The answer is simply, yes, it is perfectly ineffective. In several instances I have had guinea-pigs inoculated repeatedly with cultures in which the threads of the bacillus anthracis had become degenerated, large numbers of their sheaths and large amount of granular matter being present, but no effect was produced. The animals were soon after (from several days to several weeks) inoculated with fresh cultures of anthrax bacillus or with blood of an animal dead of anthrax, and invariably and promptly succumbed to fatal anthrax.

In my last Report I have described a peculiar, torula-like modification of the bacillus appearing in some of my cultures. I have been able to get copious growths of this torula-like modification by sowing bacillus anthracis of a culture on the mixture of gelatine and pork-broth used in former experiments and by keeping the tubes at the temperature of the room 15–16° centigrade. In the first few weeks there is a copious growth of the torula-like cells and their chains, and these gradually change into the typical apparently smooth threads of the bacillus anthracis. I have experimented with this torula-like variety and found it just as virulent as the ordinary bacillus anthracis to mice, guinea-pigs, and rabbits.

The next question for which I sought an answer, and which, as will be seen, is one of great practical importance, was this: Knowing from cultivation experiments that bacillus anthracis when growing in the depth of a fluid is not capable of forming spores, and gradually undergoes degeneration, and knowing further, from the observations of Koch and from numerous observations of my own, that within an organ of the body of an animal dead of anthrax the bacillus anthracis is not capable of forming spores, what becomes of those multitudes of the bacillus anthracis that crowd the blood vessels in the different organs, notably the spleen, of an animal dead of anthrax? A priori, I answered this question in this sense, that the bacilli undergo degeneration, just like those of an artificial cultivation in which they do not form spores. Numerous observations have taught me that this is actually the case, viz., *that the bacilli, however numerous they are in an organ of an animal at the point of death, go on after death to degenerate till they have altogether disappeared; and consequently the organs are perfectly harmless when this degeneration has become complete.*

The observations that I made with reference to this point are these: Examining sections of organs hardened, prepared, and stained with aniline dyes after the usual methods, it is found that however fresh the organs were, however soon after death they were obtained from the animal, or even if they were obtained from an animal suffering from anthrax killed some hours before it would have naturally died of the disease, there were found always some bacilli that showed longer or shorter places where the sheath (described and figured in my previous Report) was seen to be empty, not containing any protoplasm. This condition I have minutely described in my previous Report. In well and deeply-stained specimens this condition is very striking, since the part of the bacillus where the faintly-stained transparent sheath is empty of protoplasm, contrasts very markedly with that part where the sheath contains deeply-stained protoplasm.

In some of these empty sheaths are some unstained or faintly-stained granular remnants, such as I described in my former Report in connexion with degeneration of the cultivated bacillus. Such partly empty

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sheaths of bacilli I have seen in abundance in the vessels of the various organs of animals (sheep, guinea-pigs, rabbits, and white mice). I have before me sections through the liver and spleen of a sheep that died, or rather was killed in articulo mortis produced by inoculated anthrax; the sections were made of the fresh organs and stained with Spiller's purple, and I also have specimens of blood of spleen prepared after the Weigert-Koch method; in all these instances the number of bacilli with partially or totally empty sheaths was as great if not greater than those that were perfect.

The same experience I have made with guinea-pig's blood. I have specimens of blood of spleen of a guinea-pig that died of inoculated anthrax; the specimens were made a few hours after death, and the greater majority of the bacilli were partially or totally empty.

Still more striking are these relations in blood taken from the spleen of an animal dead 24 hours. I have specimens of blood of spleen of a guinea-pig prepared by the Weigert-Koch method, 24 hours after the animal died of anthrax; amongst a crowd of bacilli totally empty, or in which the sheath contained amorphous granular remnants of protoplasm, there are seen only here and there some that contained unaltered protoplasm.

There appears to be no definite rule as regards time and progress of this degeneration, but it appears to be in a relation to the general number of bacilli present, at least I have always observed that the greater the number of bacilli in the spleen in articulo mortis, the more of them have passed into a state of degeneration.

I have studied this process of degeneration in the spleen of animals dead of anthrax, guinea-pigs, rabbits, and mice, and I have invariably found that beginning with death, the proportionate number of degenerating and degenerated bacilli rapidly increases. As a rule after a week it is difficult to find a perfect bacillus, although there are many in which here and there an elementary cell, *i.e.*, a cubical mass of protoplasm is still left in the sheath. It seems to me from a comparative study that the sheaths when empty do not persist for any length of time, but altogether disappear; this is quite in harmony with the observations I made and described in my former Report with regard to the degeneration of the bacilli in artificial cultivations.

With this process of degeneration of the bacilli in the blood and organs goes hand in hand the important fact of the gradual loss of infective power of the organs of an animal dead of anthrax. I have made a great many observations with reference to this point from its obviously great practical importance, and I have no doubt about the fact *that the blood and organs kept in an animal dead of anthrax gradually lose the power to communicate the disease by inoculation.*

This is in perfect harmony with the observations of Gerlach (Die Blutsenche der Schafe, 1876), and Bollinger (Zur Pathologie d. Milzbrandes), who found that putrefaction destroys the infectivity of the blood and organs of an animal dead of anthrax.

The experiments that I made to establish this point were the following:—

I buried in soft earth, about 1–3 feet deep, mice and guinea-pigs dead of anthrax soon after death, and unearthed them after various periods from 14 days down to five days; took out the spleen and liver, minced them both up finely, and mixed them with a few minims of neutral saline solution, and injected this entire material into the subcutaneous tissue of several guinea-pigs. Not in one instance did I obtain death after such injections. After a few weeks these guinea-pigs were again

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inoculated with active cultivations of bacillus anthracis, or with a trace of blood of an animal recently dead of anthrax; invariably death from typical anthrax followed such inoculations. These observations I have repeated over and over again, and always obtained the same results, namely, absolute loss of infective power of the organs of an animal dead of anthrax after having been buried over five or more days.

Microscopic examination proved, of course, the existence of large numbers of moving bacilli in the abdominal organs of such animals, but no bacilli that could be identified as bacillus anthracis.

I have also made comparative observations on the loss of infective power of the organs in animals dead of anthrax and left simply in the air.

The result was the same in the case of animals buried, only this must be added, that if the animal had been cut open, the fluid of the cut or the opened body exposed to the air, I have found to retain its infective power for over a week or 10 days, and this is unquestionably owing to the production of spores in the bacillus anthracis; but the parenchymatous organs lose it in the same manner as those of the unopened animals.

The loss of infective power of the organs depends on the rapidity with which putrefactive changes set in; thus, for instance, while the liver and spleen are the first to lose this power, the kidney is later, and still later are the lungs.

When in one set of experiments the spleen and liver of a buried guinea-pig, that had died of anthrax, failed to infect, after five days burying, the kidney and lungs had still retained some active bacilli, since large quantities of these materials injected, produced death in half the number of animals inoculated.

But it must be added here, that it is by no means the presence of putrefactive bacteria and bacilli that produce this loss of infective power, since in this very instance of the kidney just mentioned, there were very few putrefactive organisms present, but the comparative weakening of infective power was due to degeneration in a very large measure of the bacillus anthracis.

I have also tried to ascertain whether the bacilli in the lung of an animal dead of anthrax, and kept unopened in the air, retain their life. There being some amount of free air present in the lungs, and the capillaries of the air vesicles like other capillaries containing the bacilli, I imagined that it was quite possible that these bacilli, owing to their proximity to air, might be capable of forming spores, and thus the lung might hereby be empowered to retain its infective power; but observation did not bear this out; *the lung behaved in this respect like other organs.* In the animals that I am speaking of here, and which died of anthrax (sheep, mice, guinea-pigs, and rabbits), there were no open wounds by which air might have had access to the bacilli in the vessels, and in consequence some parts of the body might have retained infeetive power.

Of course from this are excepted the evacuations of such animal, like urine, muco-sanguineous discharges of throat and nose, for these spread on the ground and exposed to the air give a very excellent opportunity for the bacillus anthracis contained in them in large numbers to form spores, and thus permanently to retain its infective power.

These relations have been minutely and admirably discussed by Koch in his paper, "Aetiologie des Milzbrandes," Mittheil. aus dem Kais. Gesundheitsamte I., Berlin, 1881.

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From all this, it is quite clear that there is no reason to attribute any correctness to the statement of M. Pasteur, viz., that in animals dead of anthrax and buried, the bacillus anthracis retains infective power for a long time (several years), that probably this prolonged infective power is due to the bacilli forming spores, and that these are brought up to the surface by earth-worms, and that hereby such fields become permanent localities of infection, and animals grazing here are liable to be infected with anthrax. On the contrary, direct experiment proves that an animal dead of anthrax loses this infective power within a short space of time,—in the case of small animals like guinea-pigs and mice it is already lost in five days,—the bacilli undergoing degeneration, and are not capable of forming spores within the organs.

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No. 2.

Memorandum on lines of Research concerning Infection and Disinfection; by J. Burdon Sanderson, M.D., F.R.S.

Introduction.

"Uncleanliness," said Mr. Simon, in his remarkable paper on "Filth Diseases and their Prevention," which serves as the introduction to his Supplementary Report, published in 1874, "must be reckoned as "the deadliest of our present removeable causes of disease."* To counteract the hurtful influence of filth is the chief aim of the sanitary administrator. It is therefore desirable that he should possess "some "intelligent appreciation of the ways in which filth becomes "destructive."

Opinion of Mr. Simon as to the nature and cause of the hurtfulness of filth

Mr. Simon proceeds to state, as the result of investigations which were in 1874 comparatively recent, that the hurtfulness of filth depends not on its offensiveness but on the existence in it of "morbific ferments," which he identifies with contagia—"matters which are not only not "gaseous, but, on the contrary, seem to have their essence, or an in-"separable part of it in certain solid elements which the microscope "discovers in them: in living organisms, namely, which in their "largest sizes are but very minute microscopical objects; and at their "least sizes are probably unseen, even with the miscroscope: organisms "which in virtue of their vitality are indefinitely self-multiplying "within their respective spheres of operation, and which, therefore, "as a contrast with common poisons can develop indefinitely large "ulterior effects from first doses which are indefinitely small."† He then divides contagia into two classes, namely, (1) those of which "man's body is the sole birthplace," and which "we see in case after "case multiplying their respective types with a successivity as definite and "identical as that of the highest orders of animal or vegetable life;" and (2) those which "confess a birthplace exterior to man, a birthplace "amid controllable conditions in the physical nature which is around "us, a birthplace amid the common putrefactive changes of dead "organic matter."

His classification of contagia.

Both are held to have intimate relations with filth, and it is on this consideration that the force of the emphatic statement from which we started, lies. It is in "filth" that the innate contagia find the conditions necessary for their continued life outside of the living body,—the extraneous ones, not only a soil but a cradle—not that the one more than the other can be stated in any exact sense to be the offspring of filth, but that the morbific ferments of the one class are in relation with "filth" from the very moment of their origin; whereas those which originate in diseased tissue are brought into relation with their filth environment only after their escape from their birthplace.

In the later paragraphs of the same paper the author discusses, with his accustomed perspicuity and force of language, the various means which the sanitary administrator has at his disposal for combating the particular evils which spring directly or indirectly from the disease producing faculty of filth. It is sufficient for my present purpose to state that as regards those forms of external uncleanliness which are

His opinion as to the value and scope of disinfection.

* Supplementary Report, New Series, No. II., page 7.

† l.c. page 15.

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the subjects of sewerage and scavenging, he attaches little value or importance to any measures excepting those of destruction and removal (in which last the prevention of accumulation is of course included), and that among the expedients which are ordinarily included under the term disinfection those only are regarded by him as valuable in which "the operations are within well defined and narrow limits," admitting that "with well circumscribed matter to work upon and with chemical "action precisely adjusted to its task we can absolutely kill any given "contagium." "In proportion as disinfection pretends to work on "indefinite quantities or in indefinite spaces it ceases to have practical "meaning." Hence the scope of disinfection seems to be practically limited to the management of individual cases of infectious disease, and the end to be chiefly kept in view in using it, that of acting on the matters discharged by each patient, whether contained in his liquid or solid excreta, or suspended in the air, so as to prevent outward spreading of his infection.

Entirely agreeing with all that has been quoted above as to the futility of general and house disinfection (meaning by the latter those "vague "chemical libations or powderings" which are habitually practised by sanitary inspectors in houses supposed to be infected), I venture to think that the destruction of solid and liquid excreta is not by any means all that can be accomplished by the application of chemical agents for the prevention of infective diseases. The innate no less than the extraneous contagia have a life history which is made up of two states of existence, alternating with or succeeding each other, one in which they vegetate more or less activity in the external environment, the other in which they have their abode in living blood or tissue, and there exercise their hurtful function. The problem of disinfection relates as closely to the latter as to the former of these states, hence the difficulties which render it so difficult to deal in any effectual way with contagia when out of relation with the living organism ought not to discourage us from attacking them either during their development within the organism or as they are entering or leaving it. After we have eliminated from our problem the futilities of house, street, and other kinds of external disinfection, there are still several important objects to be aimed at in addition to the destruction of the contagia contained in the solid and liquid discharges from the sick man's body. As regards excreta, the particulate contagia which, whether derived from respiration or not, escape by the air, are at least as potent for evil as those which are thrown off by the bowels or kidneys, although the evidence we as yet possess in respect of particular infectious diseases that such contagious particles are discharged into the atmosphere is scanty. But even the little knowledge we possess admits of sufficiently important practical application to encourage us to seek to extend it. As regards pulmonary tuberculosis the striking facts which have been lately observed as to the tuberculization of animals in rooms inhabited by consumptive persons, have suggested the possibility of danger arising from the collection of such persons in numbers under one roof in consumptive hospitals; while, as regards small-pox, the experience of Mr. Power on the prevalence of that disease in the neighbourhood of the Fulham Asylum have given occasion for seriously considering whether wards for the reception of variolous patients could not be so constructed as to insure the destruction of all living particles discharged from the bodies of the sick into the atmosphere.

Problem of disinfection.

The question, how to act effectually on contagia as they are entering the body so as to render them harmless, differs from the preceding in this respect, that, with the exception of the application of heat, the

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means used must not be destructive but exclusively of such a nature that they can without prejudice to the human organism, be mixed with the life-maintaining tide of food and air. This consideration leads us at once and without any difficulty to a practical view of the aims we ought to place before us in this branch of the art of disinfection, and renders it possible to state very definitely in what direction present knowledge can be applied, and how to seek for an extension of it. It is clearly possible to place before oneself two purposes in the application of disinfectants in the way above indicated. We may either have in view a direct action of the disinfectant on the contagia contained in the material with which it is mixed, of such a nature as to render them innocuous, or the arrest or inhibition of their morbific action within the body. The occasions which justify the first of these motives are of rare and exceptional occurrence, for in general, common sense would prescribe not the disinfection, but the avoidance of food, air, or water known to contain contagium. In certain circumstances, however (as was so lamentably the case in the recent campaign in Egypt), the consumption of contaminated water may be unavoidable, so that a knowledge of a means of rendering such water harmless might be of inestimable value. Similarly in the much more frequently occurring case in which persons in attendance on the sick are exposed to the risk of infection through the air, the discovery of an agent capable of counteracting the infective action of such air would be of incalculable service to mankind. Such a discovery is however scarcely likely to be made until better knowledge is attained as to the arrest and inhibition of contagious action within the body.

Practical aims of disinfection.

At present our knowledge of the colytic action of chemical agents within the organism is very scanty. There is, so far as I know, no instance in which the contagium of any disease communicable from person to person, or from animal to animal can, after its introduction into the organism, be controlled or inhibited in its morbific action by introducing along with it an antagonistic drug. We can oppose the development of malarious fever by the exhibition of quinine, or that of rheumatic fever by administering salicylic acid, but we cannot prevent a person who has taken the variolous poison or that of rabies, from getting small-pox or hydrophobia. The knowledge which as yet exists on the action of contagia, and particularly of what constitute the specific differences between them, is as yet so incomplete that it is impossible to say whether the discovery of specific colytics is likely to be realised or not. Hitherto no attempt has been made to seek for such agents, but now the time seems to have arrived for initiating researches in this direction. There are at least some diseases in which the first beginnings of morbific action can be scrutinised, and the mechanism of infection traced with sufficient exactitude for the purpose. However great the difficulty may be, and however slight the chance of complete success, the task is one which those who have the guidance of sanitary administration cannot escape from; the obligation rests on the consideration that every member of the community is exposed to the attacks of those hidden enemies which we have been discussing under the term contagia. Perhaps the most important lesson which has been learnt as to the nature of these enemies from the researches of the last few years is that which is expressed in the word "specificity," meaning thereby that each particular kind of contagium has a power peculiar to itself of producing a particular modification of the chemical processes which constitute the life of the organism it attacks.

The first aim of preventive medicine is, without doubt, to understand these specific modifications, the second, to learn how to control them.

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The want of sufficient knowledge of the intimate nature of contagia does not necessarily involve the futility of the investigation of disinfectants.

But in entering on the latter before we have accomplished the former of these aims, in seeking for the antidote before we know the nature of the poison, we are not only obeying an instinctive practical impulse, but are acting consistently with the principles of scientific investigation. In contagium we have to do, not with a lifeless substance, but with a living action by the exercise of which other living actions—those namely of our own bodies or the bodies of animals—are disturbed or disordered. Hence, even if our aim be restricted to the purely scientific one of finding out the nature of the action in question, we cannot work for this end more effectually than by attempting to discover how it may be antagonised. The search for specific disinfectants or colytics is one to which we are alike compelled by considerations of utility and attracted by the thirst for knowledge.

The considerations embodied in the preceding paragraphs appear to me to indicate the directions in which it is chiefly desirable that further investigations should be made with the view of acquiring a bettter and more practical knowledge of the art of disinfection. These are (1), the disinfection of liquid and solid excreta, and of clothing; (2), the disinfection of the air; (3), the detection of contagia in food, air, or water, which is about to enter the organism; and (4), the use of colytic agents with a view to the inhibition of infective action within the living body.

In the present paper I defer the discussion of the first two of these four headings, not because they can be regarded as of little importance, but because there is little hope of further advance until a better knowledge is forthcoming with reference to (3) and (4). In this connexion it may be well to note, with reference to the disinfection of air, that although it is well known that small quantities of air can be acted upon by heat in such a way as to deprive them entirely of whatever organised and consequently of whatever contagious particles they may contain, no experiments have as yet been made as to the destructive disinfection of large quantities, to the importance of which with special reference to the prevention of the spread of small-pox, I have already adverted. With reference to the other two subjects, namely, the detection of contagia in food, air, and water, and the problem of physiological or colytic disinfection, I propose now to state the considerations which seem to me to be of most value as guides in future investigations.

Those researches are at present most promising which aim at the discovery (1) of improved methods of detecting contagia and (2) of chemical agents possessed of colytic action.

In selecting methods for the detection of morbific ferments, we accept the definition of such ferments quoted above from Mr. Simon, taking as our point of departure the proposition that "they have their essence or "an inseparable part of it in certain solid elements which the micro-"scope discovers in them, and that these elements are living organisms." Whether, therefore, our modes of study be chemical or microscopical, they must be directed in the first instance to obtaining evidence of the presence of such organisms. The first question to be settled is whether microphytes are present at all; the second what are their kinds. The method of determining the first question is simple. It was indicated in my Report on the "Origin of bacteria" published in 1871. It is based on the now familiar experiment of impregnating a suitable sterilised soil (called a cultivating material) with a single drop of the water in question. If the seed thus sown germinates, the fact affords evidence that the particular drop and by inference every other drop contains germs.

Method of "cultivation."

In the attempt to pass from this first question to the second a fatal difficulty was at once encountered in the fact that all varieties of water when tested by it were found to be alike contaminated, and contained

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microphytes potentially or actually. In other words the propriety of determining the existence and multiplication of microphytes by introduction into an otherwise sterile soil, was found to be so universal that it could not be used as a means of comparison or discrimination. Nor has the progress which has been made during the last ten years in associating certain apparently specific forms, when met with in the diseased living body, with particular pathological processes (such as those of anthrax, of leprosy or of tuberculosis) as yet made it possible to recognise these very forms as they occur in drinking water or in any other ordinary soil.

Detection and discrimination of contagious microphytes in water.

Very recently however a method of cultivation has been initiated by Dr. Angus Smith which offers a more encouraging prospect. Applying certain indications afforded by the discoveries of Dr. Koch in another field of experiment to the cultivation of the microphytes of water, Dr. Smith has been able to show that by his method,—which gives, as mine did, an almost invariably affirmative answer to the question whether microphytes in ordinary water are present or not,—the crops which result from sowing these microphytes differ according to their sources. The results which he has already arrived at encourage the hope that by the use of similar or of more improved experimental arrangements in combination with the systematic study of the morphological development of his organisms for his preliminary separation or sorting of which he has given those first indications, it may become much more possible than it has been hitherto to discriminate microphytes by their objective morphological characters. [Report for 1882, page 60, of Inspector under Riv. Poll. Prev. Act.]

Knowledge of the infective properties of water can only be obtained by biological modes of investigation.

Although in the examination of water with reference to its possibly morbific qualities, the first place must be given to the detection and discrimination of its microphytes, the morphological study of these organisms by the method of cultivation is not likely to yield results of value unless it is carried on with regard to the physical and chemical conditions on which these organisms depend for their existence. A foundation for knowledge of this condition is afforded, as regards drinking water, by the ultimate analysis of the organised matter which it contains. But, however indispensable this information may be, it is by itself unavailable for the solution of the questions we have to answer. It does not even help us to discriminate between living and non-living, much less between active and inert, between hurtful and innocuous. The only chemical methods which are calculated to aid in this discrimination are such as are based on the observation of the properties which microphytes possess by virtue of their vitality; and, inasmuch as their vital activity is twofold, relating on the one hand to their evolution or development as organisms, on the other to the chemical changes which constitute their life, it is equally clear that (just as was shown to be the case as regards the microscopical ones) the methods used must relate not to the statical facts brought out by a single chemical analysis, but to the dynamical, *i.e.*, vital facts which are to be learned by the investigation of continuous physiological processes.

The physiologist habitually gauges the vital activities of organisms by the determination of the ultimate products of their vital metabolism, in other words, by determining the chemical changes which go on continuously between them and their environment. And the general result of such inquiries is that these changes are in so far characteristic that for each kind of organism there is a constant ratio between its external chemical relations and its weight. So little has been hitherto done in this direction, as regards the microphytes of water, that it is impossible to illustrate the indications I have given practically, and it would be premature to attempt to define the methods by which they might be carried into effect. My object is answered if I have shown that, in the

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examination of water for the purposes of public health it is desirable to add to the approved methods of qualititative analysis a much more complete and systematic examination of its biological properties than has hitherto been attempted—an examination which, taking its point of departure from the qualitative sorting of its microphytes (account being of course taken only of those closely relative to the microphytes of contagium) should aim at acquiring knowledge as to the morphological development of each species, and second as to its external chemical relations with its environment.

All that has been said above as to the detection and discrimination of microphytes in water is directly applicable to the question of the investigation of air; first, because there is reason to believe that air-microphytes inhabit the water particles suspended in it; and, secondly, because the only way of carrying out the examinations is by collecting its particles in water.

The search for microphytes in air and water is useful only in so far as it serves to guide us in the exclusion of infective material from the human organism. After destruction, exclusion is, without doubt, our primary duty in relation to contagia; whatever means are effectual for either of these ends, we are bound to apply as if we had no other resource. But inasmuch as however perfect our exclusive measures may be, contagia will still find their way into the human organism, the question whether or not it is possible to inhibit their action after they have so entered in spite of our exclusive prophylaxis, comes to be of very great importance.

Is it possible to inhibit the action of contagia after they have entered the human or animal organism.

In relation to this part of the problem of disinfection the disadvantage arising from want of knowledge presses upon us even more than before. The information we at present possess amounts to little more than this, that all contagia owe their power to their continued chemical action on the living substance of the organism they attack, that this action is in the chemical sense a fermentation, *i.e.*, analogous to the chemical changes produced outside of the living body by the bodies called ferments on the substance which each ferment is capable of modifying, and that in their action they more closely resemble those particular ferments which are produced by the ubiquitous organisms referred to above as common microphytes than any others. This resemblance consists, first, in their being able to produce that particular disturbance of the functions of the human or animal body, attended by diminished chemical stability of its substance and increased temperature which we call fever; secondly, on their being able to act locally, so as to induce disintegration or inflammation of tissue, wherever they are actually present; and, lastly, in their tendency to determine their own activity after the lapse of a limited period of active existence.

Comparison with reference to the above question of common with specific contagia.

These properties which the specific contagia possess in common with the septic are, however, manifested by them with the greatest possible diversity, both as regards the relative intensity of the local and general effects, and more particularly as to the order of time in which these succeed each other. For whereas the symptoms of septic infection follow immediately on the invasion of the septic poison, and as rapidly subside, the specific poison waits until a definite period (of incubation) has lapsed, and retains its hold on the infected organism for a period equally definite; the duration both of the initial delay and of the pathological disturbance which follows it being in general characteristic of the particular species.

I have thus briefly adverted to these analogies and differences between common and specific infection, because they require to be considered in relation to the practical question we have before us. Agencies which are antagonistic to septic infection at and after its penetration into the

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human or animal organisms, are known, however little may be known of the way in which they act. Is there sufficient reason for hoping that similar agencies might by investigation be discovered with relation to specific contagia? The answer to be given to this question depends on our estimate of the significance of the differences and resemblances above enumerated, and others of a similar nature. The most noteworthy of these differences is this, that the microphytes of the specific contagia in contrast to those of sepsis are of necessity adapted to a life inside the affected organism, an adaptation which in the case of the acute infections (as is strikingly seen in the relapsing fever) ceases after a limited time. Obviously this cessation must be due to the coming into existence of antagonistic conditions not before present. If it were possible to determine in what these consist, such knowledge might be expected to afford us the key to their inhibition.

Spontaneous determination of the morbid process in acute contagious diseases. Nature of the action on which it depends.

There are clearly two ways in which we might hope to attain such knowledge. We might hope to arrive at it by fortunate experience, as men are supposed to have learnt the virtues of Jesuits' bark as an antidote to malaria, or by the ordinary method of investigations of nature; that which consists in first defining the possible relationships of the unknown to the known, and then determining the value and reality of these relationships, discriminating between the true and the false, between the essential and the accidental by experiment.

In the successive evolution of contagia it can scarcely, I think, be doubted that the septic infection which is dependent on conditions which are relatively so simple must have preceded the rest in time, in other words, that all contagious microphytes are related by descent to the "common microphyte" of sepsis, and consequently that whatever properties belong to the parent are likely to be represented, more or less modified, in those of the successors. If, for example, it can be certainly stated that the instrument or agent by which the septic microphyte produces its toxical effect is a ferment in the chemical sense, we are justified in assuming that the morbific action of the microphyte of small-pox is of the same nature; and if it can be shown that the septic fermentation is necessarily brought to an end by the development of an antagonistic chemical action, there is at least ground for the surmise that the mechanism by which the variolous fermentation brings itself to an end may be of the same nature, and consequently within reach of investigation.

Spontaneous determination of the septic process. Agency of the aromatic products of sepsis in arresting the development of saprophytes.

Recent researches relating to the chemical characters and products of the septic decomposition of proteids have shown that the development of microphytes in an albuminous fluid undergoing sepsis at a favourable temperature is a terminable process, reaching its greatest activity a few days after the impregnation of the liquid with septic ferment; and that it is during this period of active vegetation that the liquid acquires its greatest toxical activity. After the culmination of the process the organisms cease to multiply and eventually die. As this takes place long before the whole of the proteid material is used up it cannot be attributed to want of nutriment, and there is good reason for regarding it as the result of the coming into existence of chemical bodies in the liquid, as the result of the breaking up of the proteid molecule, which possess the power of arresting the growth of ferment organisms. The bodies in question belong to the aromatic group, and are represented at an early stage in the septic process by acids of the acetic series in which an atom of hydrogen is replaced (as in phenyl-acetic and phenyl-propionic acids) by an aromatic group. The latter of these has been found by experiment to be destructive of the vitality of microphytes in a degree which is 20 times greater than that in which carbolic acid acts, and is such as to bring it into equality in this respect with the most powerful antiseptics known. Under conditions of

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sepsis slightly different other analogous series of aromatic compounds are produced which have not yet been subjected to physiological investigation.

Of late years physiologists have become familiar with the fact that chemical bodies belonging to the aromatic group, some of which are specifically identical with the aromatic products of sepsis, take part in the normal exchange of material of the living human or animal body. Their appearance in the urine in unnaturally large amount, when, as in cases of ileus, septic products are absorbed from the accumulated intestinal contents, indicates their relation to sepsis, and affords ground for the inference that they normally come into existence as products of a similar disintegration of the proteid molecule. That this is so is confirmed by the observation that the proteid disintegration of tissue which takes place in the animal body, in poisoning by phosphorus, occasions a prevalence of aromatic bodies, as indicated by the discharge of phenyl compounds by the kidneys, similar to that determined by the absorption of septic products.

The property which so many of the aromatic bodies possess of arresting the vitality of ferment organisms must for the present be regarded as purely organoleptic, for we can only define it by reference to the particular effects which the bodies in question produce on particular kinds of living protoplasm. Their production as fruits of the operation of the very life which, from the moment of their constitution they tend to annihilate, may be satisfactorily explained on the hypothesis that an aromatic remainder takes part in the constitution of the proteid molecule, and consequently that aromatic bodies are to be looked for among the products of its disintegration. But in biology we do not content ourselves with the discovery of the causal relation between a fact and its antecedents, but look for a complete solidarity between all the phenomena of a living organism, whether successive or collateral, a relation of such a nature as to strengthen its capacity of continued well being, and to furnish it with the means of struggling against hostile agencies.

All questions relating to the forms and even to the mechanical functions of animal and plant life, are regarded by naturalists habitually and without hesitation from this point of view, but its application to chemico-vital processes is much less familiar. There is, however, no intelligible reason why we should not take the same view of these that we do of the others. There is no reason why we should not admit that the existence in the animal body of a particular group of chemical compounds, endowed with a property which is clearly useful, as well as the metabolic process of which these are the products, is one of those "all things" which no less the form and the structure of the body and its parts work together for the good of the whole.

The purpose which I have in view in this application of the doctrine of evolution to pathology is that it may serve as an indication of the line of inquiry which it is our duty to follow in relation to it in order to eventually acquire that knowledge of its nature and mode of action, which will enable us to encounter it on its own ground; for this end two things are necessary. We should in the first place aim at substituting for the vague notions we at present possess of the action and counter-action of septic ferments and their antagonists when opposed to each other in presence of the living protoplasm of the human body, exact knowledge based on experiment and clinical observation, and, secondly, we should, employing the same methods, endeavour to extend that knowledge to the specific contagia, with a view to the eventual discovery of specific antagonists to them.

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No. 3.

On Further Researches on the Chemical Constitution of the Brain; by J. L. W. Thudichum, M.D., F.R.C.P. Lond., &c.

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1.—Introduction.

The principal object of the first part of the following inquiries has been the elucidation of the nature of those phosphorised substances of which I had given a preliminary notice in my research of 1874, under the name of *amidomyelins*. I have for the purposes of the present research isolated and analysed two representatives of this remarkable class of bodies, one *amidomyelin*, which completely bore out the theory of the composition which I had assigned to certain compounds of brain educts with platinum and cadmium chloride; another *sphingomyelin*, which was found to be almost identical with the *apomyelin* of my first research, and to be, not as I had at first surmised, a product, but a genuine educt and immediate principle of the brain. I shall show that this latter body, sphingomyelin, differs in chemical constitution from the other phosphorised matters as hitherto formulated in this, that it does not contain any glycerol, and does therefore not yield, on chemolysis, any glycero-phosphoric acid, but phosphoric acid without any attached organic radicle. This afforded a new insight into the chemical constitution of the phosphorised substances altogether, and I have therefore subjected their theory to a revision. According to the results of this revision the phosphorised substances are not glycerides at all, as commonly defined, and have nothing in common with fats, considered as glycerides, except that some of them contain certain fatty acids also present in fats, while they differ widely from fats in chemical and physical properties. In accordance with this new knowledge I have termed the phosphorised substances *phosphatides*, that is to say, substances which are similar to (but not by any means identical with)

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phosphates. I shall show that there are present in the brain and other protoplastic centres bodies which contain the phosphorised radicle twice, and may therefore be described as *diphosphatides*, the immediate principal representative of this class contains about seven per cent. of phosphorus. I shall further show that the new information confirms all I have said formerly as regards kephalin, myelin, paramyelin, lecithin, and their congeners.

As sphingomyelin on chemolysis yielded its phosphorus in the form of phosphoric acid only, I explained it to be a phosphoric acid

$$OP\begin{cases}HO\\HO\\HO\end{cases}$$

in which three radicles of HO had been exchanged for three more compound radicles. These radicles were found by chemolysis to be, firstly, a fatty acid, $C_{18}H_{36}O_2$, being the third isomer of stearic acid, *sphingostearic* acid, fusing at 57°, therefore at almost the same interval below, as the second isomer of stearic acid, namely, neurostearic acid (fusing point 84°) fuses above the fusing point of ordinary stearic acid, which latter melts at 69°·5; secondly, an alcohol of the empirical formula $C_9H_{18}O$, or $C_{18}H_{36}O_2$, which on the supposition that the latter formula expressed its atomic weight would be the fourth isomer of stearic acid; thirdly, an alkaloid closely resembling the sphingosin of the cerebrosides, $C_{17}H_{35}NO_2$, but showing a little more carbon and hydrogen, so as to answer to the formula $C_{20}H_{41}NO_2$; fourthly, to these groups a molecle of neurin, $C_5H_{13}NO$, was yet attached. Thus from its chemolysis we are able to attribute to springomyelin three somewhat different formulæ of constitution, in each of which three terms are certain, while of the remaining two terms one is certain as regards its percentic composition, but uncertain as regards its atomic weight, while the other, namely, the second nitrogenised radicle, is not yet sufficiently well defined to afford much aid to synthetical calculations. The three different formulæ of sphingomyelin are condensedly expressed in the following :—

$$OP\begin{cases}C_9H_{17}O & \text{or } C_{18}H_{35}O_2\\C_{20}H_{40}O_2N & \text{or } C_{17}H_{34}O_2N\\C_{18}H_{35}O_2\\C_5H_{13}ON & \text{or } C_5H_{11}N\end{cases}$$

The smallest formula gives a total of $C_{52}H_{104}N_2PO_7$, while the largest leads to a formula with C_{61}, but all empirical formulæ for sphingomyelin which we shall have to consider below, lead to the necessity of assuming the presence in the free body of a few molecles of water, which are not accounted for by the sum of the products of the chemical cleavage. Now it is certain that the smallest formula just given, and which is almost identical with the formula for apomyelin formerly given, is only a type, and that there are varieties in which either the alkaloid or the fatty acid or the alcohol differ from those just formulated, probably by $-+CH_2$, or $-+nCH_2$, the variation of the n not amounting, on the widest supposition, to more than nine, as above indicated. This is exactly the extent of the variation between the two formulæ of sphingol as above described; and if we consider that the increase in CH_2 of the alkaloid obtained by chemolysis beyond the quantities demanded by the formula of sphingosin, may be due to the admixture of a small quantity of a body being a compound of sphingol, $C_{18}H_{36}O_2$ and sphingosin, $C_{17}H_{35}NO_2$, total, $C_{35}H_{69}NO_3+H_2O$, then we cannot doubt that the limits of error are confined between very small dimensions.

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The typical sphingomyelin crystallises well in microscopical plates, combines with cadmium chloride in two ratios, the compounds being crystalline, and gives up one nitrogenised radicle on limited chemolysis, namely, the loosely bound neurin, $C_5H_{13}NO$, leaving an acid which contains all the phosphorus of the sphingomyelin together with half the original nitrogen, and in which, therefore, N : P=1 : 1. The formula of the acid derived from the C_{53} sphingomyelin is $C_{48}H_{95}NPO_{12}$.

Of *amidomyelin*, the immediate principle of which I had theoretically established the existence in the brain on the basis of many analyses of precipitates obtained from brain extracts by cadmium and platinum chloride, I have now practically proved the individuality by direct isolation and analysis. But I have not had either material or time to ascertain anything about its constitution by chemolysis of the pure substance. There are, however, some data available for a preliminary view of this point in a research on the chemolytic products of a cadmium-precipitate, which in the relative research I have described as the principal cadmium salt.

Amidomyelin is analogous to sphingomyelin and apomyelin in this, that it contains two atoms of nitrogen upon one of phosphorus; these two atoms of nitrogen are disposed in two different radicles, and influence the character of the compound, so that it presents itself as a diacidic base, or a dipolar alkaloid. In the latter quality it combines with cadmium chloride in two ratios, the fully saturated compound of the formula $C_{44}H_{92}N_2PO_{10}$ $(CdCl_2)_2$, requiring 30·37 % $CdCl_2$, and actually yielding to analysis 29·41 %.

The diamidated phosphatides yield hydrochlorates which crystallise from anhydrous solvents in the presence of excess of acid in exquisite form and purity, but they are not stable in the presence of watery reagents, and yield hydrochloric acid to solvents at every recrystallisation, so as to become almost free from the acid by mere repetition of this process. When the hydrochlorates are produced from the cadmium salts, they are of course mixed with double the quantity of hydrochloric acid necessary for neutral salts, and at this point great care is required so to manage the necessary warming of the mixture that the salt may be formed without any very great part of it being chemolysed under the influence of the redundant hydrochloric acid.

Of the monoamidated phosphatides I have subjected to special study *paramyelin*, already described in my first research, and *lecithin* as defined by its discoverer Gobley and by Strecker. Of paramyelin I have abundantly established the individuality, but I regret that time did not allow me to study its constitution by the analytical process of chemolysis. On lecithin I have instituted a great number of experiments, with the special object of isolating it as a pure principle. As the result of these operations I am enabled to state that no inquirer before me has isolated lecithin as a pure principle and preparation, and that I was absolutely correct when I stated in my first research that I had not then actually but only virtually proved the presence of lecithin in the brain.

The diphosphatide to which I have already alluded, in which N : P=2 : 2, and to which I have given the name of *Assurin*, has, in its platinum-chloride compound, the formula $C_{46}H_{94}N_2P_2O_9$. It is at present the most phosphorised body of this class known, while one of the least phosphorised, relatively to the nitrogen, is a phosphatide educed from the bile as a crystallised platinum-chloride salt in which N : P=4 : 1, and which has a formula by which it is characterised as a tetra-polar alkaloid, the four basic poles corresponding to the four nitrogenised radicles with which the body is endowed.

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App. B. No. 3.

Further Researches on the Chemical Constitution of the Brain; by Dr. Thudichum.

It is probable that the brain contains a phosphatide *free from nitrogen*. I have isolated and analysed such a principle, but it has to be proved to be an educt.

Thus I have shown that the phosphorised educts of the brain are a class of bodies with numerous genera, each genus having again varieties, that they are of greatly varying chemical constitution and function, and that they are so distributed as to show that they are specifically concerned in the most intimate parts and processes of protoplasmic life.

Although much work has been done regarding the *cerebrosides*, particularly *kerasin*, and although its knowledge has been greatly advanced by the discovery of processes for its separation from sphingomyelin, and more particularly from a body hitherto unknown, and to which I attribute the name of *krinosin*, yet the circumstances will not allow me to finally fix by chemolysis its rational constitution in the same manner as this has been done for *phrenosin*.

The *cerebrinacides*, or cerebrin-like bodies which combine with lead, and of which I described some in my last report, have not been treated any further. They will yet require long and important researches, not only because they are numerous, but more particularly because they occur mixed with *a class of sulphurised bodies* hitherto unknown, and of which I gave a preliminary sketch in my last report.

I have discovered an entirely new series of bodies, which are so constituted and exhibit such properties that they may perhaps be described as *nitrogenised fats*. Of these the first is *bregenin* (from the low German "bregen" head or brain), which is easily soluble in cold ether, crystallises, and has the formula $C_{40}H_{81}NO_5$. The second one is *krinosin* (from the Greek word for hair, the wavy crystals resembling a mass of tangled long hair), $C_{38}H_{75}NO_5$, insoluble in cold, easily soluble in boiling ether.

Besides what I have stated in the foregoing, I possess a good number of aperçus, all supported by chemical preparations, indicating further discoveries; the new bodies are easily distinguished by their properties from known bodies, but their exact definition has to be accomplished by further inquiry.

By my researches the brain is shown to be the most diversified chemical laboratory of the animal body; by my researches it is shown that all other organs, even when the results of their chemical action are added to them, are relatively much more simple and very much less specific in their chemical constitution than the organs producing and conducting nerve power.

(2.) Lecithin, Hypothetical and Real.

Lecithin was first recognised as the principal ingredient of the so-called "viscous matter" from the yelks of hen's eggs by Gobley*. This inquirer subsequently found the same matter in the brains of animals and human beings, and said that it was characterised by always yielding on chemolysis by mineral acids or alkalies with the greatest facility oleic, margaric, and glycero-phosphoric acid. He knew that it contained nitrogen, but was unable to ascertain the form which it assumed under the influence of the chemolytic process.

In the researches which were published during a dozen or more years following the last publication of Gobley lecithin was never mentioned until Diakonow† applied the name to a substance which he had

* *See* a Complete Abstract of Gobley's Researches in "Reports," etc., New Series, No. III., 1873, p. 224.

† *See* Abstract in "Reports" just quoted, p. 242.

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isolated from cow's brain, and to which he attributed the formula $C_{44}H_{90}NPO_9 + aq$. It yielded glycerophosphoric acid, but instead of the two fatty acids signalised by Gobley, namely, oleic and margaric, two molecles of stearic acid were said to have been obtained by its chemolysis. It was also found to yield the neurin which had previously been believed to be a specific product of decomposition of the so-called protagon. He concluded that protagon was a mixture of lecithin as defined by himself, with the cerebrin originally described by Müller.*

Lecithin (from eggs) was next examined by Strecker,† and found to yield the three acids first indicated by Gobley, namely, glycerophosphoric, oleic, and margaric acid, besides neurin, and to have the formula $C_{42}H_{84}NPO_9$.

This author also analysed some compounds of his lecithin with cadmium chloride, and platinum chloride, which led him to consider them as mixtures of different, though similarly constituted, compounds. He did not give a single nitrogen quantation, probably because his figures for that element differed even more amongst each other than the figures found for cadmium, platinum, and chlorine differed in different preparations.

Thus far, therefore, nobody had seen the principle, to which Gobley originally gave the name of lecithin, as a pure preparation, only Diakonow claimed to have analysed a pure product, which, however, differed greatly from Gobley's and Strecker's lecithin, as has been shown above. If it really had possessed the chemical constitution which Diakonow ascribed to it, it might have been termed "a lecithin," in accordance with the practice in chemical literature, whereby a specific name may be used as a generic one for bodies which are either analogous to or homologous with each other. But it should certainly not have been termed lecithin simply in the face of the precise statements and experiments of Gobley.

However, Diakonow and Strecker both admitted the probable existence of many lecithins; but while the former assumed that each lecithin contained two identical fatty acid radicles, such as two oleyls or two stearyls, the latter assumed each lecithin to contain oleyl as an unfailing ingredient and any other fatty acid radicle besides. It is probable that as regards the matters which each of these authors actually examined, analysed, and chemolysed, Strecker was correct and Diakonow in error. For while Strecker's (oleo-margaro) lecithin, even if it should ultimately be found to be a mixture, can be proved to have the constitution ascribed to it, Diakonow's dioleolecithin has never been isolated, even by this author himself, and his distearolecithin has never been isolated by anybody else. At all events, before the existence in the brain of a lecithin of the composition indicated by Diakonow can be admitted, it must be shown how the process for its isolation disposes of those lecithin-like bodies which I have described under the names of the kephalins and kephaloidins, and which contain a molecle of stearyl or margaryl, coupled with a molecle of the radicle of a peculiar fatty acid to which I have given the name of kephalic acid.

There remains indeed for comparison the body which I have termed myelin, and of which the chemolytic products are not yet ascertained. But myelin is not a lecithin (namely, a fat, an ether, and a base simultaneously), but is distinctly a dibasic acid, and of such strength that it expels acetic acid out of the lead salt without the assistance of ammonia. Moreover, the description of the properties of his lecithin

* *See* Abstract in "Reports," etc., pp. 227 *et seq.*

† "Reports," p. 244.

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given by Diakonow distinguishes it widely from myelin; the nitrogen of this lecithin, too, was nearly one fifth in excess of the quantity required by the proportion in which they are present in a true lecithin, namely, of $P : N = 1 : 1$.

From the foregoing it will be seen that what is now commonly stated in chemical and physiological works concerning lecithin refers mainly to hypothetical bodies, which have not been isolated in the pure state. If one body which can be isolated at the present time has been correctly defined by a synthetical process with the aid of the formulæ of its cleavage products, this is due to an accident mainly. But whether it be the result of skill or accident, it is certain that in the course of the operation there were left out of sight a number of principles and their cleavage products, which must have forced themselves upon the attention of the observers at every step of their analytical proceedings.

I allude to principles which I have termed amidomyelin and apomyelin, and which I have formulated so that they were shown to contain two molecles of nitrogen to one of phosphorus, or $P : N = 1 : 2$. Of these the amidomyelin I had not isolated at the time of the publication of my first research (1874), but the apomyelin had been isolated and correctly described at that time. I entertained, however, some doubt as to whether apomyelin were an educt or a product. I shall sohw in the following that it is unquestionably an educt or immediate principle, and I shall further show that amidomyelin is also an immediate principle. There may be several apomyelins and amidomyelins, but of the latter one or other is always present in the mixture termed lecithin by Gobley, Strecker, and others.

In my first research (1874) I stated that I had not actually, though virtually, isolated lecithin from the brain. I have now shown that no one else has ever isolated lecithin from the brain as a preparation and pure principle. I have shown that Diakonow obtained an excess of nitrogen over phosphorus in his lecithin, and I explain this excess by the presence in his preparation of a portion of one or other of the diamidated bodies which I shall have to describe. I have shown that Strecker gave no nitrogen analyses, probably because he found a varying excess of this element and could not explain its variation. The probability of this explanation I base upon the fact of the variations in the quantities of cadmium chloride, and platinum chloride which he found in his compounds, variations which, according to my researches, go parallel, on the whole, to those of the nitrogen in the mixtures.

Lecithin.

Definition.—Lecithin is a phosphorised and nitrogenised immediate principle of (protoplastic tissues, including brain and egg-yelks, for our present purpose of) brain tissue. There are three varieties known all containing neuryl, oleyl, glyceryl, and a third acid radicle replacing hydroxyl in the phosphoric acid; the three varieties differ as regards the third acid radicle.

Isolation.—It can be isolated by the processes sketched on p. 181 of Rep. III., 1874, but more conveniently by the following. The alcoholic extract of brain matter from which white matter has been deposited is concentrated until on cooling it forms the deposit called *buttery*. This is isolated by filtration, re-dissolved in warm spirit and treated with lead acetate and ammonia as long as a precipitate is produced and filtered hot. The filtrate deposits a crystalline mixture of cholesterin, lead salts, and lecithin. This mixture is again isolated by filtration, dissolved in hot spirit and allowed to crystallise again. To

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the solution filtered from the first deposit as well as to that filtered from the second crystals an alcoholic solution of cadmium chloride is now added, as long as a precipitate is produced; then half the volume of the cadmium chloride solution already used is added to the mixture. The precipitate is isolated by filtration and dissolved in boiling spirit; the solution, filtered hot, is allowed to deposit the salt, which is then filtered off. This is a mixture of three, may be four, compounds, one of lecithin with cadmium chloride, another of paramyelin with the same salt, a third of amidomyelin, and a fourth of sphingomyelin with cadmium chloride. The last is, if at all, present in the smallest quantity; the lecithin and amidomyelin compounds are present in about equal quantities and constitute the great bulk of the precipitate. The precipitate is dried in vacuo over sulphuric acid (when dried on the water-bath it becomes coloured), finely powdered and exhausted with ether. It is again dried and powdered and treated for the separation of the several compounds as follows:

The dry precipitate is suspended in a large volume of anhydrous benzol and frequently stirred; kephalin cadmium chloride and kephaloidin cadmium chloride are extracted at this stage; the mixture is then boiled for some time in a water-bath, and a portion of the benzol is removed by distillation. The mixture is now allowed to stand in a cold place for 24 hours and then thrown on a filter. The matter remaining on the filter is subjected to the same treatment with fresh benzol as often as may be necessary to exhaust it of all matter soluble in cold benzol. The matter insoluble in cold benzol is now again boiled with benzol and thrown on a filter kept hot by a steam-jacket. A benzol solution now passes through the filter, which deposits a compound on cooling, and keeps little or nothing in solution. This treatment also is repeated until the insoluble compound yields nothing to boiling benzol. The cadmium chloride precipitate has thus been separated (leaving the kephalin compounds out of consideration for the present) into three different matters:—

(1.) Compound soluble in cold benzol, lecithin cadmium chloride.
(2.) Compound soluble in hot benzol, deposited on cooling, paramyelin cadmium chloride.
(3.) Compound insoluble in benzol, cold or boiling, amidomyelin dicadmium chloride.

As sphingomyelin is somewhat soluble in cold alcohol, it is to be expected that a small quantity is present in the mixture of which the three compounds just defined are the principal constituents. It may be separated from the amidomyelin in the manner to be described below. But its presence in the cadmium chloride precipitate from buttery matter has not been proved; in the process of separating the educts by solvents only it remains mainly if not entirely with the cerebrosides and cerebrinacides, after the lead process with the cerebrosides only, to one of which, kerasin, it has a slight chemical affinity. This might explain its absence from the buttery matter.

Episode concerning the Shifting of Cadmium Chloride in Mixtures of Lecithin, Paramyelin, and Amidomyelin during re-crystallisation from Spirit.

It was observed that precipitates which had been exhausted with ether, and therefore were free from uncombined lecithin, after re-crystallisation from spirit left some free lecithin in the mother-liquor, which could be precipitated by renewed addition of cadmium chloride solution. It had also been observed that such precipitates containing amidomyelin showed a higher percentage of cadmium chloride than

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before. Similar data were also obtained during the treatment and analyses of the platinum salts. On the basis of these observations the following hypothesis was formed.

Amidomyelin probably combines with cadmium chloride in two proportions, namely, either with one molecle of this salt, or with two molecles, thus:

$C_{44}H_{92}N_2PO_{10} + CdCl_2$, containing 17·90 % $CdCl_2$.
$C_{44}H_{92}N_2PO_{10} + 2CdCl_2$, containing 30·37 % $CdCl_2$.

The former has a tendency to saturate itself in the presence of lecithin cadmium chloride.

$C_{42}H_{84}NPO_9 + CdCl_2$, containing 19·42 % $CdCl_2$, and during re-crystallisation from spirit, or during suspension in benzol in which the lecithin salt is in solution, takes up some cadmium chloride from a portion of the lecithin, which is thereby set free and remains in the spirituous, or as the case may be, benzol mother-liquor. This kind of shifting of the cadmium chloride is more likely to occur in anhydrous solvents, or strong spirit, whereas the dissociation under the influence of water, complete during the process of dialysis, is partial, particularly in dilute solvents or edulcorants.

Continuation of the Description of the Process.

The solutions in cold benzol obtained in the process described in the foregoing are allowed to stand for some days in the cold and repeatedly filtered. They are then concentrated, allowed to stand, and filtered again, until the residual solution remains quite clear and free from deposit. Filtration is absolutely required to prove the absence of deposits, as these are so transparent that they easily escape from observation by the eye.

The concentrated thick benzol solution, which is mostly coloured and strongly fluorescent, may now be evaporated to dryness, and the residue further studied. But it is preferable to add to it absolute alcohol as long as a precipitate ensues. Time is again wanted to complete the precipitation. The precipitate is washed with alcohol, dried in vacuo, exhausted with ether, and re-crystallised from spirit. Now a portion remains insoluble in boiling spirit, but the bulk dissolves and is deposited on cooling as a white mass, which, under the microscope, is seen to consist entirely of needles arranged radially in stars and balls.

Separation of Lecithin from Amidomyelin and Paramyelin when all are in the free state.

All three bodies are precipitated by cadmium chloride and the compounds are soluble in boiling spirit. When the mixture is decomposed in one way or another, and the resulting free bodies are dissolved in hot spirit, the amidomyelin and paramyelin separate first in the shape of white leaflets, again on concentration; from the highly concentrated spirit a mixture of lecithin and little amido- or paramyelin is at last deposited as an unctuous mass. When this is treated with ether white amido- or paramyelin remains insoluble. When the ether solution is distilled to dryness and the residue treated with *absolute* alcohol, lecithin dissolves, while again some amido- or paramyelin remains insoluble. The absolute alcohol solution deposits more amido- or paramyelin on long standing, particularly at low temperatures. But it is, perhaps, not practicable to obtain perfectly pure lecithin without a trace of amido- or paramyelin by this process, although the amido- or paramyelin obtained by it is perfectly free from lecithin. A specimen of lecithin

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thus prepared (by dialysis, &c., but not separated as $CdCl_2$ salt by by benzol) gave the following data on analysis:—

(1.) 0·8178 gave 0·1073 pyrophosphate of Mg=3·66 °/₀ P.

(2.) 1·2515 gave 0·2496 Pt=2·83 °/₀ N.

The amount of nitrogen shows that the body yet contained some amidomyelin.

The lecithin, when thus purified as far as possible, gives a white $CdCl_2$ salt which is soluble in boiling spirit, and when deposited from it leaves some coloured impurity in solution.

On the mode of separating lecithin from amidomyelin by benzol, when both bodies are combined with $CdCl_2$, *see ante*, and in the relative paragraph under amidomyelin. Paramyelin can be separated to some extent from amidomyelin by the greater solubility of its hydrochlorate, but completely only by the solubility of its cadmium chloride compound in boiling benzol, in which amidomyelin is insoluble.

Properties of Lecithin.—Lecithin is a white crystalline body, crystallising in thin plates, which when compressed form a wax-like mass. It is very soluble in spirit, being only deposited when the solution is extremely concentrated. A slight rise in the temperature causes the crystals to re-dissolve. When to its cold saturated solution in spirit water is gradually added until a permanent considerable turbidity is produced, and when this turbidity is cleared up by heating, the solution deposits on standing lecithin in the semi-solid hydrated state. Of the solution in 80 °/₀ spirit treated as described 1·1684 g left 0·036 g of lecithin on evaporation, =3·08 °/₀. The unctuous lecithin under the microscope consists of balls, in concentric layers. Lecithin is easily soluble in ether.

It is easily soluble in chloroform, and is left on evaporation as a non-crystalline mass.

It dissolves in oil of vitriol, with a yellow colour, and on addition of thick cane-sugar syrup Raspail's reaction, a purple colour, is gradually produced, changing slowly into black. The reaction is due to the oleyl radicle contained in the lecithin.

Compounds of Lecithin.—An alcoholic solution of lecithin is precipitated by *cadmium chloride;* the white voluminous precipitate amorphous at first, crystallising on standing in the mother-liquor, is easily soluble in boiling spirit, and deposited on rapid cooling in white crystalline granules; on slow cooling, acicular crystals arranged in balls and rosettes are deposited. They are very uniform and characteristic, and totally different from sphingomyelin cadmium chloride. This precipitate is insoluble in cold and boiling ether, easily soluble in benzol.

Platinum chloride; the voluminous yellow precipitate is easily soluble in ether, and again precipitated from this solution by absolute alcohol. $2(C_{42}H_{82}NPO_8)+2HCl+PtCl_4$. Also with one HCl only, and with none.

Lecithin is not precipitated by a mixture of lead acetate and ammonia.

Solubility of Lecithin $CdCl_2$ Salt in Spirit.—10 c.c. of the 84 °/₀ spirit solution which had deposited a crystallised salt, on evaporation left 0·0387 g solid matter. One part of the salt therefore requires 258 parts of spirit at 17° C. for solution.

Bearing of the Lecithin $CdCl_2$ Salt with Benzol.—When the crystallised salt is placed in pure dry benzol it swells and becomes transparent, but does not dissolve. If now the mixture be heated for some time, the salt dissolves without residue, and the clear colourless solution does not form any deposit on cooling and standing.

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Lecithin Hydrochlorate. — $C_{42}H_{82}NPO_8 + HCl$.—The pure white cadmium chloride compound is suspended in spirit, and the mixture is saturated cold with hydrothion. It is now heated in a water-bath to boiling while the current of the sulphuretted gas is continued, until the filtrate is no longer affected by it. The decomposed matter is thrown on a filter arranged on a steam-jacket, and the colourless spirit solution of lecithin hydrochlorate is separated from the cadmium sulphide. The solution deposits the hydrochlorate as a felted mass of crystals. By slow crystallisation from dilute solutions white crystals are obtained. As the cadmium chloride yields two molecles of hydrochloric acid, of which only one combines with the lecithin, the mother-liquor contains free acid in solution. As this acid decomposes lecithin at high temperatures, it is not advisable to endeavour to obtain the lecithin hydrochlorate which remains in solution in the spirit by evaporation of the latter by heat. It is preferable to extract all hydrochloric acid from the solution by mercuramin, re-precipitate the lecithin by cadmium chloride, and re-decompose this by hydrothion in a minimum of spirit. If it is desired to obtain the whole amount of lecithin in a given preparation as hydrochlorate, the body should be neutralised with the acid and the solution evaporated in a vacuum over lime and oil of vitriol.

The hydrochlorate crystallises in thin leaflets, to be seen by the microscope; they are hexagonal, frequently saucer-shaped, and owing to their extreme tenuity, mostly so distorted and crumpled up, that they appear as a confused mass of curved needles.

(*Human*) *Lecithin Hydrochlorate.*—By $CdCl_2$ from alcoholic solution of white matter and buttery. Passed through benzol process; the soluble in the cold part again re-crystallised from spirit. The white salt was decomposed by hydrothion, the solution allowed to crystallise; the crystallised mass was re-crystallised. Dried in vacuo to a perfectly white mass which could be powdered easily. At 98° it became a little soft and by prolonged heating somewhat coloured.

Analyes.

(1.) 0·3620 gave 0·0692 AgCl = 4·86 °/₀ HCl.
(2.) 0·4372 gave 0·0830 AgCl = 4·82 °/₀ HCl.
(3.) 0·3561 gave 0·0511 Pt = 2·03 °/₀ N.
(4.) 0·4372 gave 0·0672 $Mg_2P_2O_7$ = 4·29 °/₀ P.
HCl : N : P = 1·00 : 1·09 : 1·03.

(*Ox*) *Lecithin Cadmium Chloride.*

Atoms.	Theory.	Per cents.	Found.	
43 C	516	53·9	—	—
84 H	84	1	—	—
1 N	14	1·46	1·34	—
1 P	31	3·24	—	3·28
8 O	128	—	—	—
1 Cd	112	11·71	—	—
2 Cl	71	7·42	—	—
	956			
Lecithin	773	80·87		
$Cd Cl_2$	183	19·13		
	956			

$C_{42}H_{82}NPO_8 + CdCl_2$, At. W. = 942, requires 19·42 °/₀ $CdCl_2$.

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Theory of Lecithins considered as Phosphatides.

Oleo-Palmito-Glycero-Neuro-Phosphatide.

$$OP\left\{\begin{array}{l}C_{18}H_{33}O_2\\C_{16}H_{31}O_2\\C_3H_7O_3\\C_5H_{11}N\end{array}\right\}=C_{42}H_{82}NPO_8.$$

Oleo-Margaro-Glycero-Neuro-Phosphatide.

$$OP\left\{\begin{array}{l}C_{18}H_{33}O_2\\C_{18}H_{33}O_2\\C_3H_7O_3\\C_5H_{11}N\end{array}\right\}=C_{43}H_{84}NPO_8.$$

Oleo-Stearo-Glycero-Neuro-Phosphatide.

$$OP\left\{\begin{array}{l}C_{18}H_{33}O_2\\C_{18}H_{33}O_2\\C_3H_7O_3\\C_5H_{11}N\end{array}\right\}=C_{44}H_{86}NPO_8.$$

C	42	504		43	516		44	528
H	82	82		84	84		86	86
N	1	14		1	14		1	14
P	1	31	4·08	1	31		1	31
O	8	128		8	128		8	128
		759			773			787

The first three radicles in each formula replace a molecle of hydroxyl each; but the addition of neurin takes place under circumstances which engender the expulsion of a molecle of water from the neurin itself. The mobility of this molecle of water in neuriu is clearly shown in the course of the synthesis of this base.

(3.) Further Study of Paramyelin: Its Isolation, Analysis, and Compounds.

Under the name of *Paramyelin* I described in my first research on the brain an immediate principle which is a nitrogenised phosphatide, and is in the first stage diagnosed and separated by the solubility of its cadmium chloride compound in hot benzol, from which solution, filtered boiling, it is deposited on cooling. In this condition the compound is very voluminous and gelatinous, and is only with very great difficulty separated from the lecithin cadmium chloride compound which remains in solution in the cold benzol. The mechanical aids to this separation are two in number; one the cylindrical vacuum filter described in my first research, the other the use of very large volumes of benzol for the extraction of the soluble compound, the removal of the solution by the syphon from above the deposit, and very frequent repetition of this process. In this process the large volumes of benzol require many distillations for recovery; the deposition of the paramyelin compound requires time. But when once obtained free from matters soluble in cold benzol the compound behaves with great precision. It is, whilst moist with benzol, washed with spirit, which dissolves any colouring matter, and it is well to repeat this washing by shaking the compound in a bottle, &c., until the supernatant spirit is colourless. The compound thus obtained is soluble in boiling spirit, and deposited on cooling; it is easily decomposed by hydrothion in spirit, and the hot solution yields on cooling

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white crystallised paramyelin hydrochlorate. This by re-crystallisation or washing loses its acid easily, and free crystallised paramyelin remains.

Analysis of a specimen of paramyelin cadmium chloride compound obtained from the extracts of human brain by the process described under lecithin, but without the previous purification by lead. Soluble in boiling, insoluble in cold benzol. Dried at 100°; 23 g.

(1.) 0·3876 gave 0·0620 CdO (by caustic potash from nitric acid solution) = 13·70% Cd (requires 8·69% Cl).

(2.) 0·3591 gave 0·0462 $Mg_2P_2O_7$ = 3·59% P.

(3.) 0·3591 fused with flux, &c. gave 0·1405 AgCl = 9·68% Cl (this requires 15·27% Cd, whereas only 13·70% Cd were found). Total $CdCl_2$ calculated from Cl = 24·95%.

(4.) 0·4346 gave 0·0518 Pt = 1·69% N.

(5.) 0·4814 gave 0·8322 CO_2 = 47·19% C, and 0·3442 H_2O = 7·94% H.

These data exhibit the following ratios:—

$$\begin{aligned} P : N &= 1 : 1{\cdot}06 \\ P : CdCl_2 &= 1 : 1{\cdot}20 \\ N : CdCl_2 &= 1 : 1{\cdot}13 \end{aligned}$$

$$\left.\begin{array}{l} \text{If } CdCl_2 \text{ be calculated from Cl, } = 24{\cdot}95 \\ \text{then the organic molecle is } = 75{\cdot}05 \end{array}\right\} = 100$$

$$\left.\begin{array}{l} \text{If } CdCl_2 \text{ be calculated from Cd, } = 22{\cdot}39 \\ \text{then the organic molecle is } = 77{\cdot}61 \end{array}\right\} = 100$$

These relations thus show a slight excess of nitrogen over the relation N : P = 1 : 1, and a more important excess of cadmium chloride over the presumable relation N : $CdCl_2$ = 1 : 1. But considering that the compound is a first product, the relations are satisfactory, as showing the firmness of the compound. In the following I give a comparison of this salt with the paramyelin salt from ox first described.

Summary of Human Paramyelin Cadmium Chloride.

	Per Cents.	
C	47·19	
H	7·94	
N	1·69	75·05
P	3·59	
O	14·64	
(Calcd.) Cd	15·27	24·95
(Found) Cl	9·68	

Summary of Ox Paramyelin Cadmium Chloride.

	Per Cents.	
C	49·288	
H	8·299	
N	1·598	78·725
P	3·396	
O	16·144	
(Calcd.) Cd	13·020	21·275
(Found) Cl	8·255	

Computation of the Organic Molecles of these Salts.

	Per Cents.	÷ At. Ws.	÷ P = 1.		Per Cents.	÷ At. Ws.	÷ P = 1.	
408	C 62·87	5·239	34	C	62·607	5·217	37·5	456
68	H 10·58	10·58	68	H	10·541	10·541	75·8	76
14	N 2·25	0·160	1·03	N	2·029	0·144	1·0	14
31	P 4·78	0·154	1	P	4·313	0·139	1·0	31
128	O 19·50	1·24	8	O	20·510	1·281	9·2	144
649								721

The percentages of carbon and hydrogen are practically identical in both organic molecles. Other data show distinctly that the salt is not, and does not contain, either amidomyelin or sphingomyelin. The absence of lecithin follows from the solubility in cold benzol of its cad-

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mium chloride compound. The data do, however, not show that the compound is unitary, and does not contain two or more similar principles (paramyelins). They also do not show the exact composition of the organic molecle, for, as we know from a vast amount of experience, this can only be ascertained with the aid of several compounds, and of the decomposition products of the principle under the influence of chemolytic agents. For the study of these relations the past has afforded no time or opportunity, and it must therefore be left to the future.

Preparation of Free Paramyelin from the Cadmium Chloride Compound.

The $CdCl_2$ salt of human paramyelin was suspended in spirit, and treated with H_2S, at first at the ordinary temperature, later on at 75° in the water-bath, until it was completely decomposed. The filtrate, on standing and cooling, deposited white crystallised paramyelin. The crystals were rhombic and hexagonal plates of microscopic dimensions. They were collected on a filter, washed, pressed, re-crystallised from spirit, to remove a trace of colour, and the rest of the hydrochloric acid, and dried in vacuo.

Analyses.

(1.) 0·3006 gave 0·0465 $Mg_2P_2O_7$ = 4·31% P.
(2.) 0·4936 gave 0·0719 Pt = 2·06% N.

These two analyses show that N : P = 1·00 : 1·00.

The atomic weight of paramyelin as deduced from the percentage of phosphorus is 688, as deduced from nitrogen 666, mean 677 (for the free body). The atomic weight of paramyelin (human) as deduced from the organic molecle in the $CdCl_2$ salt is 649; that for ox paramyelin combined in the same manner is 721, mean 680. These two means are practically identical.

The question now arises whether this phosphatide contains glycerol or not, neurin or not; these questions can be answered by chemolysis only.

(4.) On Amidomyelin, a new Immediate Principle of the Brain its Isolation, Analysis, and Compounds.

In my first research I defined as amidomyelin a body which was met with in certain precipitates obtained from brain extracts by the agency of cadmium and platinum chloride. These precipitates were, as regards crystalline appearance and bearing towards solvents, seemingly homogeneous, but on elementary analysis they showed an irrationality between the phosphorus and nitrogen, which in not a few cases assumed the proportion of P : N = 2 : 3, all other elements being present in nearly the same average atomic proportions as those in which they are found in phosphatides in which P : N = 1 : 1. I explained these variations of the nitrogen as due to the presence of a compound in which P : N = 1 : 2. This principle I did not then isolate. But after the discovery of *apomyelin*, and lately of *spingomyelin*, in both of which principles P : N = 1 : 2, I resumed the subject, and isolated *amidomyelin* by the processes which have already been partially described under the chapter relating to lecithin. These processes had to be guided by incessant quantitative elementary analyses by which to control the progress and direction of the purification of the principle sought to be isolated. It was found that differentiating solvents and combinants were the principal means for effecting this isolation and purification, and that so-called fractional crystallisation and re-crystallisation were only of subordinate value.

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No diagnostic value was found to be attached to so-called uniform crystalline or crystallised appearances; for a great number of chemically similar or dissimilar bodies would crystallise in such a manner as to make the impression of homogeneity upon the eye, while their diversity could be quickly and incontrovertibly proved by appropriate chemical reagents.

Recapitulation of the Description of the Process for the Isolation of Amidomyelin.

The buttery matter from human or bovine brains is dissolved in hot spirit, and to the solution an ammoniacal solution in spirit of lead acetate is added as long as a precipitate is produced. This precipitate is removed by filtration on a funnel heated by steam. It contains kephaloidin and myelin as lead salts; lead salts of phosphatides, free from nitrogen, and some lead salts of crebrinacides, the latter in small quantity. The filtrate deposits on cooling a mixture of cholesterin with lead salts, particularly of myelin and cerebrinacides, and other phosphatides in the free state, amongst them some amidomyelin. The clear filtrate is mixed with a spirituous solution of cadmium chloride as long as a precipitate is produced: an excess of cadmium solution is then added, and the mixture is allowed to stand for the precipitate to contract and settle.

The mixture of cholesterin, lead salts, and other phosphatides, is again boiled with spirit and allowed to become cool without having been filtered while hot. The liquid is filtered from the insoluble and crystallised matter, and in its turn treated with cadmium chloride solution in the manner stated for the first solution. In this manner the cholesterin and lead salts mixture is extracted with spirit as long as the mother-liquors give precipitates with cadmium chloride. The last extracts are the richest in amidomyelin. The cadmium chloride precipitates are all united, washed with spirit by decantation until the washings are colourless, exhausted with ether by decantation, dried in vacuo over oil of vitriol, powdered, and subjected to the benzol process, whereby they are separated into the three different compounds which have been described under lecithin. The compound insoluble in boiling benzol is the amidomyelin dicadmium chloride compound. When the cadmium precipitates are not thrown together, but treated separately by the benzol process, it is observed that those obtained from the earliest spirit solutions contain only little amidomyelin, while this ingredient gradually increases in quantity until in the cadmium precipitate obtained from the ninth or tenth solution there is found as much as 40% of the salt insoluble in boiling benzol.

Analyses of the Amidomyelin Dicadmium Chloride Compound, insoluble in boiling Benzol from Ox Buttery after Lead Process.

(1.) 0·4177 gave 0·6705 CO_2 = 43·78% C, and 0·2964 H_2O = 7·68% H.

(2.) 0·5241 gave 0·8430 CO_2 = 43·87% C, and 0·3644 H_2O = 7·72% H.

(3.) 0·6024 gave 0·1002 Pt = 2·38% N.

(4.) 0·5684 gave 0·1022 Pt = 2·55% N.

(5). 0·3570 gave 0·0604 Pt = 2·38% N.

(6.) 0·6816 gave (by molybdate method, &c.) 0·0629 $Mg_2P_2O_7$ = 2·57% P.

(7.) 0·2163 gave 0·0200 $Mg_2P_2O_7$ = 2·58% P.

(8.) 0·3890 gave 0·1795 AgCl = 11·42% Cl, and 0·0800 CdO = 17·99% Cd (17·99% Cd require 11·44% Cl).

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Synopsis of Analyses.

	(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)
C	43·78	43·87	—	—	—	—	—	—
H	7·68	7·72	—	—	—	—	—	—
N	—	—	2·38	2·55	2·38	—	—	—
P	—	—	—	—	—	2·57	2·58	—
Cd	—	—	—	—	—	—	—	17·99
Cl	—	—	—	—	—	—	—	11·42

Mean of Analyses and Theory of Formula.

	Per cents.	÷ At. Wts.	· ÷ P = 1	÷ N = 1.	Theory.		
C	43·825	3·652	43·73	42·	C_{44}	528	
H	7·70	7·70	92·2	88·	H_{92}	92	
N	2·43	0·1735	2·07	2·	N_2	28	839
P	2·59	0·0835	1·	0·96	P	31	
O	14·045	0·8775	10·5	10·	O_{10}	160	
Cd	17·99	0·1606	1·92	1·84	Cd_2	224	366
Cl	11·42	0·321	3·84	3·70	Cl_4	142	
	100·000					1205	

$C_{44}H_{92}N_2PO_{10}(CdCl_2)_2$ requires 30·37% $CdCl_2$.
found 29·41% „
$C_{44}H_{92}N_2PO_{10}CdCl_2$ requires 17·90% „

Preparation of free Amidomyelin from the Cadmium Chlorie Compound.

(*a.*) *By the hydrothion process.*—The cadmium chloride salt described in the foregoing is finely powdered, suspended in spirit, and the mixture is saturated with hydrothion at the ordinary temperature. It is then heated in a water-bath until the spirit boils, while the introduction of the sulphuretted gas is continued until the cadmium is all transformed into the yellow sulphide. When a filtered sample of the solution is no longer altered by hydrothion, the whole is isolated by filtration on a heated funnel. On cooling it crystallises, the quicker the more concentrated it is. After 24 hours standing the crystals are collected, washed with spirit and pressed, re-dissolved in a minimum of spirit (in which, before dissolving, they melt into an oil), and again allowed to crystallise. This process is repeated until crystals and mother-liquor are both perfectly colourless. In this process there is the danger that some of the amidomyelin is decomposed under the influence of the four molecles of hydrochloric acid which are set free by the decomposition of the cadmium chloride. This chemolysis may yield some fatty acid, which may remain mixed with the amidomyelin, and is difficult to remove. In consequence, the carbon and hydrogen of the free body may be found higher than the theory derived from the salt. The free body also retains some hydrochloric acid, in the first instance, less than one per cent. (found 0·93% Cl), which diminishes to a trace by repeated crystallisation from spirit. But to remove this hydrochloric acid entirely requires a circumstantial process and the employment of silver oxyde or mercuramin, and, again, hydrothion and frequent re-crystallisation.

(*b.*) *By dialysis.*—The cadmium compound is suspended in water, and placed in a corrugated piece of vegetable parchment, folded like a plaited filter, and placed inside a funnel. The funnel is closed with a cork, or some kind of tap, at its lower aperture, and the space between

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the funnel and parchment is filled with distilled water. This is renewed as long as it contains cadmium chloride, indicated by sulphide of ammonium and nitrate of silver. *The amidomyelin is at last found to be completely dissolved in the water*, and the solution can be filtered clear through the densest filtering paper. When this solution is gently warmed it sets into a jelly. This latter may be evaporated on the water-bath with constant stirring to near dryness. The residue is dissolved in hot spirit, the solution treated with hydrothion to remove a trace of cadmium, and allowed to cool and stand. White amidomyelin crystallises, to be purified by recrystallisation, &c., as above described.

(*c.*) *From the acid mother-liquors*, filtered from the crystallised amidomyelin, the hydrochloric acid is removed by mercuramin, added in fine powder with stirring and warming. When the powder does not any longer change colour, but remains of its canary yellow colour, all the acid is precipitated. The solution is filtered warm, and yet warm treated with a little hydrothion to remove the trace of mercuramin which is dissolved in the hot spirit. It is then concentrated and allowed to crystallise; or if coloured, it is mixed with cadmium chloride solution, and the washed cadmium chloride compound is treated anew as above described.

Properties of Amidomyelin.

Amidomyelin crystallises in snowy white microscopic plates and needles, arranged in stars, and disposed in irregular masses. They dry in vacuo over oil of vitriol to a perfectly white mass, which is easily powdered, and can be dried in the water-oven below 100°. With sugar and oil of vitriol amidomyelin gives the purple of Raspail's reaction rather quickly and deeply; it is at present not known whether the reaction is due to the presence of the oleyl, cholyl, or sphingosyl radicle in the molecle of the amidomyelin. The remarkable solubility of the freshly dialysed amidomyelin in cold pure water, and insolubility in slightly warmed water, must again be pointed out. The change which it undergoes when its watery solution is warmed is permanent; the jelly produced by warmth does not re-dissolve on cooling. This phenomenon is of great importance in the study of the functions of the immediate principles in the brain; it is calling for further investigation, and comparison with the bearing of the other phosphatides under similar conditions. One of these, not yet accurately identified, has the property of being slimy and diffused and unfilterable in cold water, while becoming hard and contracted in boiling water, so that the water can be filtered off. This substance, with fresh cold water, gradually resumes the slimy immensely hydrated condition.

Theory of Amidomyelin (Ox) as deduced from its Cadmium Chloride Compound, and Comparison with the Theory of Sphingomyelin (Apomyelin).

Taking the organic molecle from the analysed $CdCl_2$ salt, with 29·42% $CdCl_2$, namely, 70·59%, and calculating elements for 100, we get—

	For Amidomyelin—				Sphingomyelin gives— $C_{52}H_{104}N_2PO_9 + H_2O$.		
	Per Cents.	÷ At. Wts.	Atoms.	At. Wts.	Per Cents.	Atoms.	
C	62·15	5·179	44	528	68·37	51·86	624
H	10·93	10·93	92	92	11·29	107·52	106
N	3·37	0·24	2	28	2·96	2·	28
P	3·65	0·117	1	31	3·24	1·	31
O	19·90	1·24	10	160	17·14	10·2	160
				839			949

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Diagnosis and Separation of Amidomyelin from Sphingomyelin.

Elementary analysis, with special regard to the relations between N, P, and C is as yet the only means of establishing a diagnosis between these two principles. It is satisfactory that in the first steps of brain extraction they separate in the main, amidomyelin remains with paramyelin and lecithin, while sphingomyelin remains with the cerebrosides and cerebrinacides. But the analyses of sphingomyelin in early stages of purification make it probable that it is mixed with a mononitrogenised phosphatide as insoluble in cold spirit as itself, a body closely resembling or identical with paramyelin. From paramyelin, we know from these researches, amidomyelin is easily separated by the benzol process applied to cadmium chloride salts. This process will therefore aid to separate paramyelin from sphingomyelin also. But at the time of the composition of this report it had not yet been possible to exactly fix the bearing of sphingomyelin and its cadmium chloride salt towards benzol, nor to establish its absolute diagnosis and absolute separation from amidomyelin when both occur in a state of admixture with each other. Neither was there time or material for the study of the chemical constitution of amidomyelin by means of the chemolytic method, which I have shown abundantly in the course of these researches to be the only means for obtaining precise final knowledge regarding the atomic composition and weight of these marvellous ingredients of the brain, nerves, and protoplastic centres.

(5.) On Sphingomyelin, a new Immediate Principle of the Brain, Type of the diamidated Phosphatides, which contain no Glycerol; its Isolation, Analysis, Chemolysis; and Compounds.

In chemical researches which have to deal with the separation of the ingredients of complex mixtures, the difficulties generally rise with the atomic weights of the bodies to be treated. Of this rule, sphingomyelin, a body the atomic weight of which is probably one of the highest after those of the albuminous class, has furnished a striking confirmation.

Sphingomyelin is the principal, but not the only, phosphorised ingredient of the so-called cerebrin mixture, which remains when white matter is exhausted by ether. I may remind the reader that this mixture, after one or two crystallisations from spirit, is termed "protagon" by a few writers who are unable to appreciate the true state of affairs. Apart from the direct proofs which have dispelled the theory of "protagon," and have shown it to be a mere fallacy, we have now the great facts, that out of this mixture there have been isolated entire series of immediate principles: first and best studied, the *cerebrosides*, with *phrenosin* as their chief; secondly, the *cerebrinacides*, which contain more oxygen than the former, and combine with lead; thirdly, bodies containing sulphur as an essential ingredient, hence termed *cerebrosulphatides*. To these we have now to add the description of *peculiar phosphatides*, which contain the phosphorus and part of the nitrogen erroneously believed to be elementary components of the immediate principle "protagon" and certain nitrogenised substances free from phosphorus, which may be termed *nitrogenised fats* or *amidolipotides*. The processes described in the following are those which actually led to the discoveries by which they were rewarded. But it is probable that, after a complete knowledge of the properties of the newly discovered bodies has been obtained, these processes may be much simplified and shortened.

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Process of separating apparently homogeneous Crystallised Bodies from the Alcohol used for the separation of the Cerebrosides; which Bodies will be shown to be Mixtures by reagents.

After the removal of phrenosin and kerasin by crystallisation from absolute alcohol frequently repeated, there remained alcoholic solutions, which made no further deposit on standing. These were distilled to a small bulk, and deposited a white crystallised matter. (An attempt to separate anything out of the matter by benzol proved abortive; cold benzol extracted but little, on application of heat all dissolved, and on cooling the mixture set into an unmanageable jelly. The benzol was therefore distilled off and the matter treated anew with spirit.) The crystalline matter was dissolved in hot spirit of 85°/₀ strength, and an alcoholic solution of lead acetate was added, after this a slight excess of ammonia. The cerebrinacides contained in the body were thus precipitated as lead salts. From these the solution was separated hot by filtration. After cooling, the alkaline mother-liquor was separated from the crystalline deposit. The washed crystalline mass was dissolved in hot spirit, and left much matter in a fused state (second lead stearoconote). A part of the matter, being yet insoluble lead compound, should remain undissolved, but when fused it encloses a quantity of soluble matter, which then remains inaccessible to the spirit. It has been found useful to emulge the crystalline matter with some water, before heating it with spirit. This resolution in hot spirit and re-crystallisation are repeated four times, or until no lead salt remains insoluble and until the product is uniformly white, and crystallised in stars and rosettes of needles, clearly visible under the microscope. It is dried in vacuo.

Properties of the Product.—With water it forms a permanent jelly or paste like starch pap. With sugar and sulphuric acid it gives an immediate purple reaction; with sulphuric acid alone it becomes thoroughly purple. Heated to 90° to 100° in a wateroven it becomes a little soft and a little coloured; when cold it becomes again pulverisable. It fuses at about 150°, assuming a brown colour. It yields to absolute ether-alcohol a considerable amount of matter, which crystallises in the original rosettes and branched masses, like lycopodium.

Preliminary Elementary Quantations.

(1.) 0·6605 dried at 90°, gave 0·0529 $Mg_2P_2O_7$ = 2·24°/₀ P.
(2.) 0·6481 gave 0·1201 Pt = 2·63°/₀ N.
(3.) 0·5131 gave 1·1064 CO_2 = 58·81°/₀ C, and 0·5336 H_2O_1 = 11·55°/₀ H.
(4.) 0·6286 gave 0·6633 H_2O_1 = 11·72°/₀ H.

Synopsis of Results.

	Found in 100.	÷ At. Wt.	÷ P = 1.
C	58·81	4·900	68·05
H	11·55	11·55	160·40
N	2·63	0·188	2·61
P	2·24	0·072	1·
O	24·77	1·548	21·50

These data show that the body, though crystallised as described, was yet a mixture. Its principal ingredients were *sphingomyelin*, in which P : N = 1 : 2, and *kerasin*, which latter mainly explains the excess of carbon and nitrogen and attached water, as will be shown below.

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Comparison with this Rosette or Lycopodium-like Body of a similar Body obtained from the Cerebrin Mixture by Ether, together with the Kephalin, &c.

The ether extracts from white matter containing all kephalin, myelin, cholesterin, &c., were concentrated and mixed with an alcoholic solution of lead acetate. Kephalin and myelin became insoluble as lead salts. When the precipitated matters were boiled with spirit, and the filtrate was allowed to cool, cholesterin, together with a lead compound and the new body were deposited. The deposit was isolated. dried and extracted with ether not in excess. Cholesterin dissolved, while the lead salt and new body remained undissolved. The latter mixture was treated with boiling alcohol, which dissolved the new body, and deposited it on cooling in crystalline rosettes, while the lead salt remained undissolved as a fused mass. By frequent re-crystallisation of the new body as long as it left any fused lead-compound, it was at last obtained quite free from lead, and white.

Chemical and Physical Properties.—White crystalline mass. Becomes soft at 90°, without loss of water. Gives Raspail's reaction with and without sugar, from which the presence of a cerebroside may be inferred. The lead compound gave the Raspail reaction with and without sugar, if at all, very indistinctly.

Analyses of the Rosette Body.

(1.) 0·3918 gave 0·0186 $Mg_2P_2O_7 = 1·33\,\%$ P.

(2.) 0·4268 gave 0·9182 $CO_2 = 58·67\,\%$ C, and 0·4294 $H_2O = 11·18\,\%$ H.

(3.) 0·1371 gave 0·0268 $H = 2·78\,\%$ N.

Synopsis of Results.

	Per Cents.	At. Wt.	÷ P = 1.
C	58·67	4·889	119
H	11·18	11·180	272
N	2·78	0·198	4·82
P	1·33	0·041	1·
O	26·04	1·627	39·5

It will be seen that the empirical formula of this mixture is very similar to the formula which Liebreich gave for his "protagon," namely, $C_{116}H_{241}N_4PO_{22}$, but like this, it is only the formula of a mixture; the ingredients of this mixture are, however, by no means identical with those of the "protagon" mixture, as is already evident from this, that they were soluble in much ether, in which "protagon" is insoluble. In fact the crystallised body just analysed is a mixture of a dinitrogenised phosphatide, *sphingomyelin*, with *a cerebroside*, as was clearly shown by the application of reagents. But the nature of the cerebroside in this case was not ascertained as in the former case.

Isolation of Sphingomyelin by Cadmium Chloride Process.—Many attempts (of which only two have been described in the foregoing) having been made to isolate a constant product by mere crystallisation with solvents, without success, the cadmium chloride process, already described in previous researches, was again adopted. The reagent was mainly applied to cold alcoholic solutions, and had the following effect. A precipitate of $CdCl_2$ salt ensued immediately. If this was filtered off quickly, a second more gelatinous precipitate fell, consisting of almost pure kerasin. The $CdCl_2$ salt also contained yet some kerasin. From this it was separated by boiling spirit; the $CdCl_2$ salt was

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deposited mainly above 28°, the kerasin entirely below 28°, and on long standing provided that the amount of kerasin did not rise above 1 part in 321 parts of spirit. Of the $CdCl_2$ salt spirit retains less than half a per cent. (weight in volume) in solution. It is probable that the body or bodies which combine with $CdCl_2$ (sphingomyelin and other phosphatides) on the one hand, and kerasin on the other hand keep each other in solution by some attraction which they have for each other, in which sphingomyelin acts as base, kerasin as acid, the result being a kind of salt, which is more soluble in spirit than each of its components by itself. The alcoholic solution from which the $CdCl_2$ salt and kerasin have been precipitated, must be allowed to stand long, and be repeatedly concentrated, to remove all kerasin. It then yields a precipitate with platinum chloride and hydrochloric acid, which is a compound of a phosphorised and nitrogenised body, *assurin*, with the reagents employed. The mother-liquor yields *krinosin and bregenin*, nitrogenised matters free from phosphorus, and belonging to the new class of *amidated lipotides* or *nitrogenised fats*, as will be fully described lower down.

Gradual Purification of the $CdCl_2$ Salt of Sphingomyelin by re-crystallisation from boiling Spirit and Extraction with boiling Ether.

In the course of these processes it was found that the precipitates might contain varying quantities of $CdCl_2$, and that these might correspond to several compounds. Sphingomyelin might combine with one or two molecles of $CdCl_2$; the second phosphatide might combine with one molecle of $CdCl_2$ only, being a mononitrogenised body, probably paramyelin. The $CdCl_2$ might also be depressed by the admixture of kerasin It was also found that the $CdCl_2$ would shift, so as to increase in one fraction, while diminishing in another of a previously unitary preparation.

The changes of these salts in general, and the extraction of the kerasins and other admixtures in particular, were followed analytically. Thus a CdCl salt gave the following data:—

(1.) 0 5698 fused with nitre in tube, &c. gave 0·13756 AgCl = 0·03402 or 5·97 °/₀ Cl; also 0·07096 CdO = 0·06209 or 10·89 °/₀ Cd = 16·86 °/₀ $CdCl_2$. The 5·97 °/₀ Cl require in theory 9·41 °/₀ Cd = 15·38 °/₀ $CdCl_2$. The salt here obtained was the one with one molecle of $CdCl_2$; sphingomyelin with 51 carbon atoms and $CdCl_2$ postulates 16·4 °/₀ $CdCl_2$; the body with 53 carbon atoms requires 15·98 °/₀ $CdCl_2$.

Another salt from ox cerebrosides mother-liquor of re-crystallisation was a mixture of sphingomyelin $CdCl_2$ in which N : P = 2 : 1, and of a phosphatide $CdCl_2$ salt, in which N : P = 1 : 1, probably paramyelin. The salts were crystallised from hot spirit above 30°, and re-crystallised until free from kerasin.

Quantations.—(1.) 0·5632 gave 0·0846 CdO, equal to 13·14 °/₀ Cd, and 0·0654 Mg pyrophosphate = 3·24 °/₀ P; and 0·2078 AgCl = 9·12 °/₀ Cl.

(2.) 0·2762 burnt with soda lime, &c. gave 0·0442 Pt = 2·28 °/₀ N.

(3.) 0·5482 burnt with chromate gave 1·0192 CO_2 = 50·70 °/₀ C, and 0·4482 H_2O, equal to 9·08 °/₀ H.

The chlorine found in analysis (1) postulates 14·3 °/₀ Cd. There is, therefore, a slight deficiency of this element. The organic molecle has

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therefore to be calculated by deducting the latter larger figure for Cd, namely, 14·3 °/₀ thus:—

$CdCl_2$ - - -	23·42 °/₀
Organic molecle - -	76·58 ,,
	100·00

This quantity of $CdCl_2$ indicates that the mixture contains sphingomyelin monocadmium chloride with sphingomyelin dicadmium chloride, bodies which will be discussed more explicitly lower down. The nitrogen is to the cadmium chloride in such a proportion that the basicity of sphingomyelin is unsatisfied to the extent of about one quarter, or upon two atoms of nitrogen there is very nearly one and a half molecle of cadmium chloride (1·48).

Synopsis of the foregoing Analytical Results.

	Per Cents.	÷ At. Wt.
C	50·70	
H	9·08	
N	2·28	0·162
P	3·24	0·104
O	11·28	
Cd, Cl_2	23·42	
	100·00	

Calculation of Elements in 100 *of Organic Molecle.*

	Per Cents.	÷ At. Wt.	÷ N = 2.
C	66·21	5·5175	51·8
H	11·86	11·860	111·2
N	2·98	0·213	2·
P	4·23	0·136	1·26
O	14·73	0·921	8·64

The relation of C : N are the same as those of the same elements in the crystallised free body, which will be described lower down. Consequently the phosphorus is somewhat too high.

Further purification of the Compound by Ether, and by re-crystallisation.—The mixture was now subjected to a process of purification by being exhausted in a closed apparatus with boiling ether. When new ether failed to extract anything during an entire day of boiling, the compounds were re-crystallised from spirit, again dried, and again exhausted with ether. If now fresh ether extracted nothing, the salts were considered to be fully exhausted. (Some krinosin and bregenin were extracted.) In this manner a number of preparations were purified, with the result that in all the carbon sank a little, while cadmium chloride rose in quantity, but nitrogen remained to phosphorus as 2 : 1·28, as will be seen from the following analysis.

Quantation of Elements in $CdCl_2$ Salts from Ox Cerebrosides, No. 1, *after exhaustion with boiling Ether, dried at* 98°.

(1.) 1·1561 were deflagrated with flux in a tube and gave 0·1332 magnesium pyrophosphate, equal to 3·22 °/₀ P.

(2.) 1·1561 gave 0·4566 °/₀ AgCl = 9·77 °/₀ Cl.

(3.) 1·0070 gave 0·1591 Pt = 2·24 °/₀ N.

(4.) The same salt also gave 46·11 °/₀ C and 8·66 °/₀ H.

(5.) The Cd amounted to 15·63 °/₀.

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Synopsis of Quantations and Theory of Salt.

	Per Cents.		÷ At. Wt.
C	46·11		3·84
H	8·66		8·66
N	2·24		0·160
P	3·22		0·104
O	14·37		
Cd	15·63	} 25·40	
Cl	9·77		

Elements and Theory of Organic Matter.

	Per Cents.	÷ At. Wt.	÷ N = 2
C	61·80	5·15	48·5
H	11·60	11·60	—
N	3·00	0·214	2·
P	4·31	0·139	1·28
O	19·29	1·205	—

We have therefore here also the phosphorus too high for sphingomyelin, namely, N : P = 3 : 2, from which it may be surmised that the admixture was partially a mononitrogenised phosphatide (paramyelin?) partly a diphosphatide such as will be described lower down.

The $CdCl_2$ salt No. II. was extracted with ether and dried at 100°, when it became slightly coloured.

Analysis.—0·7546 gave 0·0856 pyrophosphate of magnesium, equal to 3·17% P. This is very near the quantity yielded by the first salt.

The $CdCl_2$ salt No. III. was extracted with ether and dried at 100°, and also became slightly coloured.

Analyses.—(1.) 0·7221 gave 0·1102 Pt = 2·18% N.

(2.) 0·4688 gave 4·0640 magnesium-pyrophosphate equal to 3·81% P.

While therefore the nitrogen corresponded to that in salt No I., the phosphorus was higher than in salts No. I. and No. II.

As no even relation between nitrogen and phosphorus could be obtained by any kind of treatment, particularly frequent re-crystallisation, to which the compound was subjected, it was deemed necessary to decompose it and study the free body. It was evident from the relation C : N = 51·8 : 2 that the organic body was not a phosphatide of the lecithin group, in which C : N = 42 : 1, or thereabouts, while the amount of nitrogen pointed to the probability that the body was constituted similarly to the amidomyelins which had been hypothetically assumed to exist in analysed $CdCl_2$ and $PtCl_4$ compounds. In fact it was at once perceived to present the proportions between C and N which had been observed upon *apomyelin* described in my first research on the brain. But as it had been left doubtful whether this apomyelin was not a product rather than an educt, great care was taken to prevent any chemolytic influence from acting on the body, so that the doubt just mentioned might be eliminated. The crytallisation of the free substance showed at once the presence of *two principles*, of which the first, *sphingomyelin*, was obtained pure by crystallisation, while the second one was obtained pure by more circumstantial processes to be described later.

Preparation of pure Sphingomyelin from its Cadmium Chloride Compound.

Removal of the Cadmium by Diffusion and Dialysis.—When the compound is placed in water this will extract much of the $CdCl_2$, but not all, by dissociation and diffusion. But the liberated sphingomyelin

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is in the state of colloidation, which increases with the length of contact with water until it reaches its maximum. The liquid can thus no longer be filtered from the sphingomyelin, as the latter immediately obstructs the pores of the filter.

Dialysis may be resorted to, the apparatus being arranged with plaited vegetable parchment dialysers as described in a former chapter. When the dialysate is free from $CdCl_2$ the sphingomyelin and water paste must be concentrated, dissolved in hot spirit, treated with hydrothion to remove the last portions of cadmium, and set to crystallise.

The sphingomyelin which was examined in the first four analyses to be related below, was prepared with the aid of dialysis as follows:—40 g $CdCl_2$ salt was boiled with 1 l spirit, 23 g dissolved, while 13 g remained insoluble in the quantity of spirit mentioned. The hot spirit solution deposited a quantity of salt above 30° and was filtered at 30°. The salt thus obtained was subjected to dialysis and washed with water until free from chlorine. It was then re-crystallised from spirit and dried at 100°.

The liquid which had deposited the $CdCl_2$ salt above 30 was evaporated, and the deposit filtered off. It was also decomposed with water, and the body free from $CdCl_2$ was analysed. It yielded results which have been recorded separately. If my object were solely that of a mere chemist in search of new pure compounds, I should have thrown this and other mother-liquors away. But the object of physiological and pathological research is not to find some principles which will pay the chemical operator, but *to find all the principles* which may be contained in an organic physiological or pathological mixture.

The following process yields sphingomyelin in a shorter time than dialysis. The purified salt, free from kerasin and all matters which ether can extract, is suspended in spirit, and treated with hydrothion to saturation. The flask containing the mixture is now placed in a water-bath, the water of which is gradually raised in temperature, until the spirit in the flask boils. The influence of the sulphuretted gas is continued until a filtered sample of the spirit solution is not changed by the hydrothion any more. The mixture is now filtered through paper in a funnel kept hot by a steam-jacket. The filtrate is left to crystallise. It yields sphingomyelin, &c., partly as hydrochlorate, which are collected on a filter, washed with spirit, pressed between bibulous paper, and dried in vacuo over oil of vitriol. The neutral and dry salts are now again dissolved in warm spirit, and to the solution is added gradually and in small finely pulverised quantities as much mercuramin as may be necessary to bind and retain in the precipitate all the hydrochloric acid combined with the phosphatides. When an excess of mercuramin is present, *i.e.*, when the deep canary yellow colour of the mercuramin is no longer changed to white, but remains as a yellow deposit at the bottom of the flask, distinct from the white mercuramin hydrochlorate, then the organic principles are free from hydrochloric acid; the filtered solution, on cooling, deposits, first, sphingomyelin, to be purified by re-crystallisation; the concentrated mother-liquor deposits the mononitrogenised companion mainly. (Without the mercuramin treatment the sphingomyelin may retain from 0·8 to 1·32 % HCl.)

Physical and Chemical Properties of Sphingomyelin.—Sphingomyelin is easily soluble in hot spirit or absolute alcohol, and crystallises therefrom in dense white masses, needles, stars, and hexagonal plates. It does not become waxy after drying, but retains a pulverulent dryness. It is little soluble in cold absolute alcohol, but can be separated thereby from phrenosin, which is less soluble, and from lecithin, which is more soluble. It is almost insoluble in ether even when some hydrochloric

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acid has been added. It cannot be separated from kerasin, to which it stands in the relation of a base, by re-crystallisation alone. The intervention of cadmium chloride is necessary to effect this separation. The compound of sphingomyelin with cadmium chloride is less soluble in spirit than the pure sphingomyelin, and is deposited in a much shorter time and at higher temperatures than kerasin. For the sphingomyelin $CdCl_2$ falls above 28°, kerasin (in solutions which contain less than 1 g in 321 c.c. of spirit of 84 %) below 28°, on standing. Sphingomyelin swells in water and becomes distributed in it so as to form a turbid semisolution or emulsion. In the course of dialysis it sometimes contracts and sinks in the water. Its compounds, particularly those with $CdCl_2$, become decomposed under the influence of water; sphingomyelin assumes the colloid form, and the combined metals or salts pass into solution in the water. On this property rests the process for liberating sphingomyelin from crystalloids by dialysis.

Quantations of Elements in Sphingomyelin from Ox Brain.

(1.) 0·7649 gave 1·8336 CO_2 = 65·37 % C, and 0·7770 H_2O = 11·29 % H.

(2.) 0·5602 gave 0·1169 Pt = 2·96 % N.

(3.) 0·9942, gave 0·1154 $Mg_2P_2O_7$ = 3·24 % P.

Synopsis of Analyses and Theory.

	Per Cents.	At. Wt.	÷ P = 1.
C	65·37	5·445	51·86
H	11·29	11·29	107·52
N	2·96	0·211	2·
P	3·24	0·105	1·
O	17·14	1·070	10·2

The probable formula is $C_{52}H_{104}N_2PO_9 + H_2O$.

Comparison of Sphingomyelin with Apomyelin from Human Brain.

In Reports No. III. (1874) p. 164, I have given the analysis of a specimen of a kind of myelin from the human brain which I termed *Apomyelin*, and which had been obtained from a platinic chloride compound by re-crystallisation from boiling alcohol, and decomposition of the product by hydrothion. The following figures were given:—

Apomyelin, Man.

	Per Cents.	÷ At. Wt.	÷ P = 1.
C	67·01	5·5841	54
H	11·35	11·35	109
N	3·00	·2142	2
P	3·23	·1041	1
O	14·694	·9155	9
Cl	0·761		

This was therefore clearly a sphingomyelin with 54 C; like the sphingomyelin from the $CdCl_2$ compound, it retained a small quantity of hydrochloric acid, which was estimated in the analyses and recorded as Cl. A sphingomyelin prepared from $CdCl_2$ salt, by H_2S, was found to retain 1·32 % HCl, which is only about a third of the theoretical amount required by a simple hydrochlorate. In both cases the hydrochlorate was probably decomposed by the influence of watery solvents.

Chemolyses of Sphingomyelin, with a view of ascertaining its Chemical Constitution.

I have made four distinct experiments on this subject, but as they are not completed, I am only able to state the salient results of the operations as far as they go.

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Experiment I.—6 g sphingomyelin were mixed with 12 g baryta hydrate and heated to 105° during five hours. There were obtained a little *sphingosin* (precipitated from the alcoholic extract by sulphuric acid, soluble in excess), an acid which differed from sphingomyelin by the absence of the group of *neurin*, *sphingomyelic* acid, probably (if the sphingomyelin employed had the formula $C_{63}H_{106}N_2PO_{12}$) having the composition $C_{48}H_{95}NPO_{12}$. In this acid it will be observed P : N = 1 : 1. There was further obtained a *barium salt, soluble in ether*, and an alcohol *sphingol*, the two latter bodies being products of the continued decomposition of a portion of sphingomyelic acid.

Experiment II.—12 g sphingomyelin and 12 g baryta and 50 g water were heated to 100° for 10 hours. There were obtained 1·1 g of neurin as platinic chloride salt, while theory requires 1·3 g from 12 g sphingomyelin. *No trace of glycerophosphoric acid was observed.* There was a barium salt insoluble in alcohol and ether, which contained P : N = 1 : 1·02 (P = 2·75 °/₀; N = 1·27°/₀) sphingomyelate of barium. No sphingosin was obtained. But the new alcohol, *sphingol*, was isolated in sufficient quantity to be analysed.

Analysis of Sphingol, a new Alcohol, from Sphingomyelin by Chemolysis with Baryta.

Dried at 98° in a platinum boat.

(1.) 0·2576 g burnt with lead chromate gave 0·7207 CO_2 = 76·30 °/₀ C, and 0·2962 H_2O = 12·78 °/₀ H.

(2.) 0·2908 burnt in a platinum boat, with lead chromate and oxygen gave 0·8171 CO_2 = 76·34 °/₀ C, and 0·3259 H_2O = 12·45 °/₀ H.

Synopsis of Analyses and Theory.

		Per Cents.	÷ At Wt.	÷ by O = 1.
(1.)	C	76·30	6·37	9·07
	H	12·78	12·78	18·7
	O	10·92	0·68	1·
(2.)	C	76·34	6·361	9·08
	H	12·45	12·45	17·92
	O	11·21	0·7	1·

The new alcohol has therefore the composition expressed by either $C_9H_{18}O$, or by $C_{18}H_{36}O_2$. In the latter case it would be the fourth stearic isomer.

Analysis of the Neurin-Platinum-Chloride Hydrochlorate obtained from this Chemolysis.

The salt $C_{10}H_{26}N_2O_2$, 2 HCl, $PtCl_4$, of atomic weight 618·4

	Requires in 100.	Found in Salt.
Pt	31·921	31·79
Cl	34·44	34·64

Experiment III.—20 g sphingomyelin and 40 g baryta, with 500 g of water were heated to 135° during 12 hours. There were obtained *neurin*; further a second *alkaloid* precipitated by sulphuric acid from its solution in absolute alcohol, yielding as sulphate by analysis the formula 2 ($C_{20}H_{41}NO_3$) H_2SO_4, being possibly somewhat impure sphingosin; sphingol; a fatty acid, which as barium salt and as lead salt was insoluble in alcohol and in ether, in the free state had the composition expressed by the formula $C_{18}H_{36}O_2$, crystallised, and fused at 57°, therefore almost

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as much below ordinary stearic acid, which fuses at 69·5°, as neurostearic acid fuses above this, namely, at 84°. The acid is therefore the third isomer of stearic acid, and is named *sphingostearic acid.*

No glycerophosphoric acid was obtained, but the insoluble barium salt contained much *barium phosphate*, which was isolated; the phosphoric acid was combined with molybdate of ammonium, and fully identified.

Experiment IV.—25 g sphingomyelin, 50 g baryta, and some water were heated in the autoclave to 105°—120° for 17 hours. There were again obtained neurin, sphingosin, sphingol, barium salt insoluble in ether, and a neutral body mixed with sphingol; this latter mixture or compound had the formula $C_{35}H_{81}NO_5$, with 2·18 N.

Some intermediate, in quantity subordinate, products, such as a barium salt soluble in ether and precipitable by alcohol remain for further study.

Theoretical Results of these Chemolyses.

The conclusions to be derived from these chemolyses bearing upon the chemical constitution of sphingomyelin are of the utmost interest and importance.

(1.) In the first place no glycerophosphoric acid was obtained in any one of the chemolyses. If I recall the many experiments made regarding the constitution of other phosphatides, such as of kephalin or of lecithin, and the relative facility with which glycerophosphoric acid was isolated as barium salt and identified as calcium salt, I cannot suppose for a moment that glycerophosphoric acid has been present and escaped observation. I therefore came to the conclusion that the glycerol found in a portion of the phosphatides was not, as had been hitherto supposed, essential to the composition of those bodies. From this moment it was also evident that glycerol could not, or need not, be the basal radicle of these compounds, not even of those which contained it, and that therefore the phosphorised brain educts could no longer be considered as glycerides, or ethers of the alcohol glycerol, but had to be differently interpreted. The only feature common and essential to all the phosphorised educts, and the one from which in consequence they derived their appellation, was that they contained phosphorus, which by ordinary analytical processes remained in the form of phosphoric acid. There was no reason to suppose that the phosphorus was present in the organic principles in any other form than that of phosphoryl, the radicle of phosphoric acid. (When they were chemolysed they took up water, and yielded hydrated radicles, such as have been described, acids, alkaloids, or organic bases, and alcohols.) Consequently I assumed that *the basal radicle of all phosphatides was that of phosphoric acid; that in this acid one, two, or three molecles of hydroxyl might be replaced by radicles of alcohols, acids, or bases, and that to a molecle formed by three such substitutions there might yet be attached, by substitution of an element in a radicle, itself already substituted* (side-chain) *or by addition as anhydride, a fourth radicle*, and that therefore sphingomyelin might be constituted according to the following formulæ:—

Phosphoric acid = OP { HO, HO, HO }

Sphingomyelin = OP { Acid radicle. / Alcohol radicle. / Base radicle (substituted). / Base radicle (attached as side-chain or added as anhydride.) }

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I repeat the formula, substituting elementary formulæ for the functional symbols :—

$$OP\left\{\begin{matrix}C_{18}H_{35}O_2\\C_{18}H_{35}O_2\\C_{17}H_{34}O_2N\\C_5H_{11}N\end{matrix}\right\} = C_{58}H_{115}N_2PO_7.$$

To this formula we are obliged, by the results of the analyses of the free sphingomyelin, to add at least $2\,H_2O$, perhaps $3\,H_2O$, and by this operation we obtain a total formula of $C_{58}H_{121}N_2PO_{10}$.

But this last formula is only a case out of many possible formulæ. It is clear that if the molecular formula of sphingol were only $C_9H_{18}O$, the formula above given would either have to be lowered to C_{49}, &c., or the sphingol would have to be assumed to be doubly represented. Neither hypothesis enjoys the advantage of probability. I therefore do not presume to fix the exact formula of sphingomyelin, particularly as I have shown that there are various sphingomyelins, (one being apomyelin), but I maintain that this research has established as a type of brain educts sphingomyelin, which is a phosphatide, and contains an alcohol not being glycerol, an acid, and two nitrogenised radicles as proximate constituents.

Compounds of Sphingomyelin—The body combines with *hydrochloric acid*, and this compound is more soluble in spirit than the free body. The hydrochlorate is easily dissociated by watery solvents, so that while a monohydrochlorate should contain 3·76 % HCl, there were found in a hydrochlorate re-crystallised from spirit only 1·32 % HCl.

Compounds of Sphingomyelin with Cadmium Chloride. — The varying quantities of cadmium chloride in such compounds have been a source of great trouble and doubt, which could only be solved by countless preparations and analyses by the hand of hypotheses and the atomic theory. Thus a salt was found to contain 16·86 % $CdCl_2$, and to correspond to the formula $C_{51}H_{99}N_2PO_{10}CdCl_2$, which requires 16·4 % $CdCl_2$.

Another salt from the human brain contained 26·59 % $CdCl_2$, and was therefore supposed to be a not quite saturated compound approaching that with two molecles of $CdCl_2$. For the C_{51} sphingomyelin with $2CdCl_2$ requires 28·% $CdCl_2$; the formula with C_{52} requires 27·9 % $CdCl_2$.

Sphingomyelin is therefore, like amidomyelin, a dipolar alkaloid, and capable of fixing one molecle of $CdCl_2$ to each of its two nitrogen radicles.

Consequently any sphingomyelin and $CdCl_2$ compound which contains quantities of $CdCl_2$ intermediate between 16·4 % and 28 % is a mixture of the monocadmium chloride, with the dicadmium chloride compound. Such a compound must of course contain P : N = 1 : 2. Where these relations do not subsist, but where the relations of P : N approach more or less those of 2 : 3, the cadmium chloride may be diminished by the presence of a compound with it of a phosphatide such as paramyelin, in which P : N = 1 : 1. It will therefore be seen that the higher the amount of $CdCl_2$ found in a new precipitate, the more likely is the body to contain sphingomyelin (or amidomyelin). If the $CdCl_2$ sinks much towards 20 % or below, the precipitate or crystallisation either contains much of the monocadmium chloride compound, or contains a mononitrogenised body, which may be either a body analogous to sphingomyelin, but containing one nitrogenised radicle only, or a lower phosphatide such as lecithin or paramyelin.

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We have therefore, with regard to sphingomyelin, the possibility of the existence of two compounds and an indefinite number of their mixtures in different proportions:

$C_{51}H_{99}N_2PO_{10} + CdCl_2$, At. W. = 1113 contains 16·4 % $CdCl_2$.

$C_{51}H_{99}N_2PO_{10} + 2(CdCl_2)$, At. W. = 1296 contains 28 % $CdCl_2$.

If there are, as is probable, many sphingomyelins, then each variety would have its several $CdCl_2$ compounds.

All these $CdCl_2$ salts are beautifully crystallised and white. When they are re-crystallised from spirit they lose solubility as the extraction proceeds. These changes are particularly observed upon salts which are not fully saturated with $CdCl_2$: the fully saturated salts behave in a regular and stable manner. It is therefore necessary in the first crystallisation to offer to sphingomyelin an excess of cadmium chloride, and to test the mother-liquors of re-crystallisation from time to time to see that they do not contain unsaturated more soluble salt or free sphingomyelin in solution. Spirit of 85 % strength, after having been saturated boiling with the dicadmium chloride salt and allowed to deposit all it can during 24 hours, will keep in solution half a gramme of the salt in 100 cubic centimètres.

(6.) On Assurin, a new Immediate Principle of the Brain, Type of the Diamidated Diphosphatides; its Isolation and Analysis.

This body is found in the alcohol extracts of the cerebin mixtures after sphingomyelin and kerasin have been removed from them in the manner above indicated. When to such a solution platinum chloride, acidified with some hydrochloric acid is added, a precipitate ensues which is insoluble on boiling. In solution there remains a body, which I have termed *Istarin*, and which does apparently not combine with platinum chloride. Both bodies, assurin and istarin, seem to have some attraction for each other, like sphingomyelin and kerasin, which causes them to crystallise together, so as to represent a uniform appearance of star-shaped masses of crystals. This union is apparently never definite, but the proportions of the ingredients shift according to the mass, concentration, and temperature of the solvents used for their extraction. On the whole, frequent re-crystallisation from spirit causes the phosphorus in the mixture to rise, and the nitrogen to sink relatively to the phosphorus. But the principle here to be described is isolated as yet only by platinum chloride.

Assurin Hyrochlorate Platinum Chloride.

Yellow crystalline powder, insoluble in boiling spirit, and in ether.

Analyses.

(1.) 0·2071 gave 0·3740 CO_2, and 0·1630 H_2O, = 49·25 % C, and 8·74 % H.

(2.) 0·1780 gave 0·3199 CO_2, and 0·1420 H_2O, equal to 49·01 % C, and 8·85 % H.

(3.) 0·4090 gave 0·07216 Pt = 0·010235 N = 2·50 % N.

(4.) 0·5370 gave 0·08716 Pt = 0·012363 N = 2·30 % N.

(5.) 0·1789 gave 0·01616 Pt and 0·07436 AgCl, equal to 9·03 % Pt, and 10·27 % Cl.

(6.) 0·2130 gave 0·01826 Pt, and 0·08226 AgCl, equal to 8·57 % Pt, and 9·55 % Cl.

(7.) 0·4541 gave 0·10606 $Mg_2P_2O_7$ = 6·52 % P.

(8.) 0·2400 gave 0·05206 $Mg_2P_2O_7$ = 6·06 % P.

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Synopsis of the Results of Analyses Nos. 1, 3, 5, 7, *and Theory.*

	Per Cents.	÷ At. Wt.	÷ Pt = 1.	Organ. Molecle.
C	49·25	4·104	91·20	45·6
H	8·74	8·740	194·22	97·0
N	2·50	0·178	3·95	1·97
P	6·52	0·210	4·66	2·33
O	13·69	0·855	19·00	9·5
Pt	9·03	0·045	1·00	
Cl	10·27	0·289	6·42	

These data lead to a formula $2(C_{46}H_{94}N_2P_2O_9+HCl)\ PtCl_4$.

Synopsis of the Results of Analyses Nos. 2, 4, 6, 8, *and Theory.*

	Per Cents.	÷ At. Wt.	÷ N = 2.	÷ Pt = 1.	Organ. Molecle.
C	49·01	4·084	49·8	94·3	47·
H	8·85	8·85	—	203·	101·
N	2·30	0·169	2·	3·77	1·88
P	6·06	0·1954	2·2	4·49	2·24
O	15·66	0·98	—	22·	11·
Pt	8·57	0·0435	—	1·	
Cl	9·55	0·269	—	6·18	

These data lead to a formula $2(C_{47}H_{101}N_2P_2O_{11}+HCl)\ PtCl_4$, which differs a little from the former one, but phosphorus remains slightly exceeding, nitrogen below the theory derived from the platinum chloride as starting base. Assuming nitrogen at two atoms, we come to nearly 50C, but encounter again an excess of ten per cent. in the phosphorus. But the great features of the results of the quantations are evident. We have to deal with a phosphatide in which the radicle of phosphoric acid is contained twice, and which we may therefore term a *diphosphatide*. In this principle there are contained two atoms of nitrogen, which from analogy with other phosphorised bodies, we may suppose to be contained in two different nitrogenised radicles. But even if the two atoms of nitrogen were contained in one and the same radicle, it would still be perfectly correct to term the principle a dinitrogenised diphosphatide. For the nitrogen, although somewhat deficient in both sets of analyses, amounts nevertheless to 3·77 molecles in the latter and to 3·95 in the first set of quantations when compared to platinum as 1.

The companion of assurin, the above-mentioned *Istarin*, is not phosphorised, but it is very difficult to prepare it free from the last traces of phosphorus. Its chemical composition is expressed approximately by the formula $C_{40}H_{82}NO_6$; it therefore seems to belong to the group of nitrogenised fats to be described below. I have prepared and analysed many specimens which have shown the way to the ultimate complete chemical individualisation of the substance. But there has not been time for the carrying out of the laborious operations, which are necessary for the isolation of the quantities required. For it must be borne in mind that before istarin is reached in a systematic course of brain analysis all the other substances described previously must have been removed out of the solution, as well as the residues of the solvents and precipitants.

(7.) Further Study of Kerasin, the second Cerebroside, with a view to fixing its Chemical Constitution, and separating it from Sphingomyelin.

In my first Report on the Chemical Constitution of the Brain (1874) I have described the principal features of this remarkable immediate principle of the brain. As in the case of phrenosin, I have, up to the

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From Report of 1874:—

	Per Cents.	÷ At. Wt.	÷ N = 1.
C	68·446	5·704	46·0
H	11·395	11·395	92·0
N	1·738	0·124	1·0
O	18·421	1·151	9·2

The two first sets of analyses are probably to be preferred, and it is very probable that the formula of kerasin is $C_{42}H_{85}NO_8$, or $C_{44}H_{89}NO_8$; any formula giving oxygen as eight atoms has theory in its favour, as we shall see below. But in any case the formula cannot be established by analysis alone; chemolyses of kerasin and analyses of the cleavage products are required to enable us to form a final opinion as regards its chemical constitution.

Chemolysis of Kerasin.—I have already proved in a former research that kerasin is a cerebroside, and yields cerebrose by chemolysis with dilute sulphuric acid. For the purposes of the present research I began some chemolyses with baryta, which could, however, not be completed. In particular, the study of the acid products of the chemolysis could not be accomplished for want of quantity. But the basic parts were identified in two forms, and the presence of cerebrose was incidentally confirmed.

Four g of kerasin were mixed with 8 g of baryta hydrate crystals, and sufficient water to produce a thin paste. The mixture was enclosed in a tube and heated during 14 hours to 100°. The watery solution, free from baryta, gave a reaction for cerebrose. The insoluble in water part was extracted with alcohol; the concentrated solution yielded a precipitate of a sulphate. Another part of the matter was not precipitated by sulphuric acid, but remained in solution. It was shown to be psychosin, like the base of the precipitated sulphate. This sulphate dried to a horny mass on the filter, and did not remain pulverulent like sphingosin sulphate. It was dissolved in boiling water, with which it formed a clear solution, and precipitated with a large excess of caustic alkali. It did not rise to the top like an oil, as sphingosin does, on heat being applied, but formed a jelly or semi-soap; with more potash it became emulged; the solution became turbid on cooling; ether extracted nothing from it. The only way to extract the alkaloid was to acidify the solution with sulphuric acid, and add phosphomolybdic acid to it. The precipitate, after decomposition with baryta, yielded to spirit the psychosin, which was transformed into sulphate and analysed.

Analyses of the Sulphate obtained, and Comparison with the Composition of Psychosin Sulphate and Sphingosin Sulphate.

	Found in Product from Kerasin.	Psychosin Sulphate. $2(C_{23}H_{45}NO_7)\,H_2SO_4$.	Sphingosin Sulphate. $2(C_{17}H_{35}NO_2)\,H_2SO_4$.
C	54·67	55·65	60·11
H	10·48	9·27	10·78
SO_4	10·59	9·67	14·37

As the sulphate yields Raspail's reaction without sugar being added, it must be psychosin, mixed, however, with a small trace of sphingosin.

It follows from the foregoing that kerasin, like its principal companion phrenosin, is a cerebroside, namely, a body which contains the sugar *cerebrose*, combined with at least two other radicles. Of these, one is probably *sphingosin*, the alkaloid obtained from phrenosin. The other is certainly a *fatty acid*, but the nature and composition of this acid have not yet been perfectly ascertained.

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(8.) On Bregenin, a new Immediate Principle of the Brain, Type of a new Class of Bodies termed Amidolipotides or Nitrogenised Fats; its Isolation and Properties.

I have isolated the principle from both human and bovine brains. It crystallises, fuses like a fat, and contains nitrogen. It is extremely soluble in several reagents, and does not combine with acids, alkalies, or salts.

Mode of Isolation.—Human cerebrins in hot alcoholic solution were treated by baryta water for the purpose of removing the phosphorised ingredient. (I have shown in previous reports that the vaunted purification does not take place.) The precipitated cerebrin bodies were freed from baryta by sulphuric acid in alcohol and re-crystallised. The most soluble part contained the bregenin. From this sphingomyelin was removed by cadmium-chloride; the resulting solution was now evaporated to dryness and extracted with cold benzol; kerasin remained undissolved, while bregenin and some other matters dissolved in the benzol. The matters dissolved in benzol were treated with boiling ether in a suitable apparatus, when a body remained insoluble in boiling ether, while two bodies dissolved; one was deposited from the ether on cooling, *krinosin*, to be described below, while another remained dissolved in the cold ether, namely, *bregenin*. After removal of the ether the bregenin was dissolved in a minimum of watery spirit, filtered hot, and allowed to crystallise. When after repeated crystallisation, removal of the mother-liquor by pressure between bibulous paper, &c., the product consisted of white microscopic leaflets and curved needles only, it was considered pure and analysed. Its solution in spirit does not give precipitates with cadmium or platinum chloride, or with lead acetate, with or without ammonia. As long, therefore, as in a supposed or reputed solution of bregenin such precipitates are produced, they have to be removed as impurities. It is much more soluble in absolute alcohol than in watery spirit; from the former it is deposited as a white solid mass, when the solution is concentrated; when dilute no deposit at all may take place; it is useful to dilute the hot alcoholic solution with boiling water until a permanent turbidity is produced, and allow the mixture to cool. Good crystals are obtained from such a solution.

From a concentrated spirit solution bregenin crystallises between 50° and 25°. At 30° it is not completely deposited. A dilute spirit solution becomes hazy about 40° and begins to crystallise only at 25°. When thus deposited slowly it appears in balls and irregular masses, without any curved needles. These balls can be transferred into needles by resolution in spirit and rapid cooling down of the solution.

Physical and Chemical Properties of Bregenin.—Besides the characters already described in the foregoing, bregenin has the following diagnostic properties. When heated in a water-oven it becomes a little coloured, and then fuses below 98° to an oily fluid. On cooling it solidifies to a hard mass, which is not plastic like fat or wax, but splinters, when cut, in all directions, and is highly electrical. Its fusing point is between 62° and 65°. When the fused and re-congealed body in the filiform tube is again heated, it becomes in part transparent about 62°, but a core remains opaque until a higher temperature is reached, when all is again fused. This is due to the viscosity of the fused body. At the lowest fusing point it is transparent, but so viscous, as to be hardly mobile, or only very slowly mobile; with rising temperature it becomes as fluid as a molten fat, and the interval between the point of fusion and the point of greatest liquidity is considerable. While it

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fuses and coalesces in the narrow tube at 62° to 65°, it flows down the sides of the tube only at 75° to 76°, and then on cooling sets with a sudden appearance of opacity at 58°. These experiments were made with the purest specimen, which had been kept in a fused state in the water-oven for hours. The bearing of bregenin with water is very remarkable. When heated with much water, it fuses like a fat, on the top of it. But on agitation it increases in bulk and becomes visco-gelatinous. This hydration, which is completed only on long standing in the water, causes it to increase in bulk considerably. When the swelled mass, after decantation of all water, is heated on the water-bath, it contracts, gives out water, and fuses as in its original state while all water is being evaporated.

With oil of vitriol it gives no purple on standing; the solution remains a little yellow. When sugar syrup is added to this solution it becomes perfectly white, and gives no vestige of purple. From this it is highly probable that bregenin does not contain the radicles either of oleic acid or of sphingosin.

The fused bregenin, when quite cold again, can be powdered. In this state it was subjected to elementary analysis.

Elementary Analyses of Bregenin (from Ox-Brain).

(1.) 0·1675 burnt with copper, &c. gave 0·4520 CO_2, and 0·1891 H_2O, equal to 73·59 °/₀ C, and 12·54 °/₀ H.
(2.) 0·2537 burnt with CuO gave 0·6853 CO_2 and 0·2951 H_2O, equal to 73·69 °/₀ C, and 12·92 °/₀ H.
(3.) 0·2063 burnt as before gave 0·5577 CO_2, and 0·2333 H_2O, equal to 73·72 °/₀ C, and 12·56 °/₀ H.
(4.) 0·5247 gave 0·08216 Pt = 2·22 °/₀ N.
(5.) 0·5220 left 0·0794 Pt = 2·15 °/₀ N.

Synopsis of Analyses and Theory.

	1.	2.	3.	4.	5.	Mean.	÷ At. Wt.	÷ N = 1.
C	73·59	73·69	73·72	—	—	73·66	6·138	C_{40}
H	12·54	12·92	12·56	—	—	12·64	12·64	H_{81}
N	—	—	—	2·22	2·15	2·18	0·155	N
O	—	—	—	—	—	12·52	0·781	O_5
						100·00		

This body, *bregenin* (from the low German "bregen," head or brain, the latter English word being probably a contraction merely of bregen), $C_{40}H_{81}NO_5$, is thus shown to be approximate in the number of its carbon atoms to both the mononitrogenised phosphatides and to the cerebrosides. From the latter it is sharply distinguished by the low amount of oxygen which it contains. It has almost exactly the composition of the lowest phosphatide of the lecithin group minus the phosphoric acid, for

$$C_{40}H_{81}NO_5 + PH_3O_4 = C_{40}H_{83}NPO_8 + H_2O.$$

This might make us suspect that it was derived from such a group by the mere loss of phosphoric acid, and consequently that it might be a product and not an educt. But such a mode of decomposition of a phosphatide has no analogy in the decompositions which have thus far been artificially produced. For in these phosphorised bodies when they

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contained glycerol, this alcohol remained mainly with the phosphoric acid. Supposing, as a mere hypothesis, that bregenin did contain glycerol, then there would be no room for neurin as the nitrogenised radicle. In the absence of neurin, the nitrogenised radicle would have to be one which does not occur in the mononitrogenised phosphatides, as far as they are known, and this would negative the suggestion that bregenin might be derived from such a phosphatide by loss of phosphoric acid. Besides, such a hypothesis also presupposes that the binding radicle is an alcohol like glycerol, and that phosphoric acid is outside the nucleolar arrangement, and merely attached as a side-chain,—a theory which is clearly impossible for those phosphatides, which, as I have shown, contain no glycerol, and is therefore not probable for the others which contain it.

Bregenin is obtained by the foregoing processes in small quantities only, and a great number of preparations were required to yield material sufficiently pure for analysis. It is evident that the greater part of the bregenin present in the brain must, in the process of extraction, pass into the alcoholic and ethereal solution containing lecithin and kephalin; then it must at last remain with the cholesterin, where we accordingly find it. And it is separated from this only by treatment with caustic potash, which chemolyses and removes the products of bregenin, while leaving cholesterin unaltered. It will therefore be seen that much further study will be required to elucidate the physiological quantities and functions of this remarkable substance.

(9.) On Krinosin, a new immediate Principle of the Brain, second Homologue of the New Series of Nitrogenised Fats, or Amido-Lipotides: its Isolation and Properties.

Mode of preparing Krinosin.—Dry, finely-powdered crude kerasin as obtained from the process for the isolation of sphingomyelin by cadmium chloride is exhausted in the ether extraction apparatus by boiling ether. The solvent should be perfectly anhydrous, and be renewed from time to time until it extracts nothing more. For the extraction is but slowly completed, and in most cases requires the apparatus to be kept in action for several days. The hot ether solution deposits krinosin on cooling and standing as a voluminous felted mass of long microscopic fibres, a wilderness of mere lines, mostly without visible end. If the vessel has not been agitated during the cooling process, the felted mass forms a complete jelly with the ether. By strong agitation this structure is destroyed, and there remain only a few lumps of felted matter, looking like bluish paper pulp in an abundance of water. The fibres, having been collected on a filter, dry to a hard mass, when moisture, so easily collected by the cold produced in the course of the evaporation of the ether, is allowed to deposit upon them; when only little moisture has been in contact with them, they dry to a white spongy matter, which is just a little waxy on compression or when rubbed with the finger-nail. When the fibres, taken out of the anhydrous ether, are dried in vacuo over oil of vitriol, they become a perfectly white and pulverisable mass. When this powder is now heated in a water-oven to 98° for some time, it becomes somewhat plastic and assumes a yellowish colour. After cooling it is again hard and perfectly pulverisable, but retains the colour acquired by the heating. Krinosin is insoluble in cold, easily soluble in boiling alcohol. It gives no purple reaction with sulphuric acid alone, and none with sulphuric acid and cane sugar. It is consequently not a cerebroside, and does not contain any oleo-cholide radicle.

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Elementary Analyses of Krinosin prepared as described in the foregoing.

(1.) 0·2976 gave 0·0454 Pt, equal to 0·006434 N, or 2·16 °/₀ N.
(2.) 0·3000 gave 0·0464 Pt, equal to 0·00657 N, or 2·19 °/₀ N.
(3.) 0·2052 on combustion with lead chromate, gave 3·5360 CO_2, equal to 0·1461 or 71·19 °/₀ C, and 0·2354 H_2O, equal to 0·0262 or 12·74 °/₀ H.
(4.) 0·1942 dried at 98° gave 0·5034 CO_2, or 0·1373 C, = 70·70 °/₀ C, and 0·2069 H_2O = 0·02298 H, or 11·83 °/₀ H.

Synopsis of the Mean of Analyses and Theory of Formula.

	Per Cents.	At. Wt.	÷N=1.
C	70·94	5·911	38·1
H	12·28	12·28	79·
N	2·17	0·155	1·
O	14·61	0·913	5·8

Consequently the nearest formula warranted by the quantation is $C_{38}H_{79}NO_5$. Leaving out of consideration a slight excess of hydrogen, probably due to the substance in analysis 3, not having been dried at a higher temperature, but only in vacuo, there seems good reason to suppose that krinosin is a homologue, in an isomeric series, of bregenin, for, we have

Bregenin - $C_{40}H_{81}NO_5$
Krinosin - $C_{38}H_{77}NO_5$

The homology is probably not in the same series, as the higher carbonised bregenin fuses below 70°, while krinosin does not fuse below the heat of boiling water.

(10.) Review of the Immediate Principles of the Brain and their Derivates which I have discovered in the course of my Researches and described in these Reports.

For the phosphorised principles I adopt the theory of constitution and name which I have given in the introduction, and for which the motives are set forth in the article on sphingomyelin.

Phosphatides.

Of these there are two classes.
I. *Non-nitrogenised Phosphatides.*
II. *Nitrogenised Phosphatides.*
Of the non-nitrogenised class only *monophosphatides*, that is to say, bodies which contain the radicle phosphoryl only once, are known; of the nitrogenised class, however, *diphosphatides*, which contain the radicle phosphoryl twice, are known; the monophosphatides are again divided into *mononitrogenised and dinitrogenised.*

I. *Non-nitrogenised Monophosphatides.*

Such an acid is the product *kephalophosphoric acid*, $C_{35}H_{72}PO_9$, the lead salt of which had the formula $C_{35}H_{70}PbPO_9$; it had been derived from kephalin by short chemolysis, and was apparently produced by the loss of neurin and glycerol only. Considered as a phosphatide it would have the constitutional formula:—

$$OP\left\{\begin{matrix} C_{17}H_{28}O_3\ (\text{kephalyl}) \\ C_{18}H_{35}O_2\ (\text{stearyl}) \\ HO \end{matrix}\right\} + 2H_2O$$

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Or if it contained glyceryl, in which case however the carbon as found by analysis is rather deficient:—

$$OP\left\{\begin{matrix}C_{17}H_{28}O_3\\C_{18}H_{35}O_2\\C_3H_7O_3\end{matrix}\right\}=C_{38}H_{70}PO_9.$$

If we add to this group the anhydrous radicle of neurin, $C_5H_{11}N$, we have kephalin, $C_{43}H_{81}NPO_9$.

Two similar acids occur in the buttery matter, and form insoluble lead salts, namely:—

First (crystallised) Acid from Buttery Matter.
Second (non-crystalline) Acid from the same.

These bodies have not yet been sufficiently studied; it is certain that they are monophosphatides into the constitution of which nitrogen does not enter, but it is not certain whether they are educts or products.

2. *Nitrogenised Phosphatides.*

Of these the following varieties are known, namely, *monophosphatides* and *diphosphatides*. The monophosphatides occur as *mononitrogenised* and as *dinitrogenised*, but the diphosphatides have as yet been observed as dinitrogenised only.

A. Mononitrogenised Monophosphatides.

$$N:P=1:1.$$

Group of the Kephalins.

Kephalo-stearo-glycero-neuro-phosphatide, kephalin.

$$OP\left\{\begin{matrix}C_{17}H_{28}O_3\ (\text{kephalyl})\\C_{18}H_{35}O_2\ (\text{stearyl})\\C_3H_7O_3\ (\text{glyceryl})\\C_5H_{11}N\ (\text{neuryl})\end{matrix}\right\}C_{43}H_{81}NPO_9.$$

To be a kephalin a phosphatide must contain the radicle *kephalyl* or a a homologue, which governs most of the properties of the product; its peculiar properties prevail over those of the second acid.

A kephalin with palmityl $C_{16}H_{31}O_2$, in place of stearyl would have the summary formula $C_{41}H_{77}NPO_9$, a kephalin with margaryl, $C_{17}H_{33}O_2$ would be $C_{42}H_{79}NPO_9$. If there were several homologous kephalic acids, such as some analyses seem to indicate, then for a kephalyl of formula $C_{18}H_{30}O_3$ combined with either stearyl, margaryl of palmityl, the foregoing formulæ would have to be increased by CH_2 each, so that the most complicated kephalin might contain 44 atoms of carbon. None of these hypotheses explain either the deficiency of hydrogen, or the excess of oxygen (namely as compared to the theory derived from chemolysis) in the various kephalins, and their compounds which have been analysed. This discrepancy can only be eliminated by further researches carried on by the light of those given in the foregoing:—

Kephalin, empirical formula - - -	$C_{43}H_{79}NPO_{13}$.
,, perhaps - - -	$C_{42}H_{69}NPO_8+5H_2O$.
Kephalin cadmium chloride - -	$C_{42}H_{79}NPO_{13}$, $CdCl_2$.
(Dissociates partly in watery reagents.)	
Kephalin hydrochlorate platinum chloride	$2(C_{42}H_{79}NPO_{13}HCl)\ PtCl_4$.
Kephalin with amidokephalin (Mixture) -	$\left\{\begin{matrix}C_{42}H_{80}N_2PO_{13}.\\2(C_{42}H_{79}NPO_{13}.)\end{matrix}\right\}$
Oxykephalin cadmium chloride - -	$C_{42}H_{79}NPO_{14}$, $CdCl_2$.
Peroxykephalin - - - -	$C_{42}H_{79}NPO_{15}$.
Peroxykephalin, diplumbic - -	$C_{42}H_{75}Pb_2NPO_{15}$.
Kephaloidin - - - -	$C_{42}H_{79}NPO_{13}$.
Oxykephaloidin cadmium chloride -	$2(C_{42}H_{75}NPO_{14})CdCl_2$.

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There is no doubt of the existence of a dinitrogenised kephalin, termed *amidokephalin* which was mixed to the extent of one third nearly with a preparation of kephalin described in the research. This body is less soluble in ether than kephalin. It is no doubt constituted analogously to the amidomyelin described in a special research. But as this amidokephalin has not been finally examined, I am unable to give any further data concerning it.

Of the decomposition products of kephalin by chemolysis I have already mentioned kephalophosphoric acid under the non-nitrogenised monophosphatides.

Kephalic acid is the principal chemolytic product of the process in which the phosphatide is almost entirely severed. All its salts are soluble in ether, and insoluble or little soluble in alcohol. It assumes, in the free state or in combination, a brown colour, from which it has not yet been possible to free it by any known process. The formulæ which can be constructed for the acid vary between $C_{19}H_{32}O_3$ and $C_{17}H_{28}O_3$, or $C_{17}H_{30}O_3$, and $C_{17}H_{32}O_3$. They are mainly derived from *barium salts*, which contain from 18·28 to 20·05 °/₀Ba.

Kephalate of barium. Easily soluble in ether.

Kephalate of lead. Easily soluble in ether.

Stearic acid, $C_{18}H_{36}O_2$, m.p., 69·5, examined in the free state and as barium and lead salt.

Stearate of barium, $2(C_{18}H_{35}O_2)$ Ba.

Stearate of lead, $2(C_{18}H_{35}O_2)$ Pb.

Glycerophosphoric acid, $C_3H_9PO_6$ (a monophosphatide) was isolated from kephalin as :—

Lead salt, $C_3H_7PbPO_6$.

Calcium salt, $C_3H_7CaPO_6$, and in the new form of

Acid calcium salt, $C_6H_{16}CaP_2O_{12}$.

Barium salt, $C_3H_7BaPO_6$. This could be obtained crystallised, monohydrated, and as alcoholo-hydrate, in which latter state one molecle of—

Acid barium salt, $C_6H_{16}BaP_2O_{12}$, therefore composed similarly to the calcium salt, contained at least three molecles of alcohol and six of water.

Kephalin further yielded—

Neurin, $C_5H_{13}NO$, and another base, perhaps derived from neurin.

The second base in amidokephalin was not made out.

Group of the Lecithins.

$$N : P = 1 : 1.$$

I have given the explicit formulæ of these bodies considered as phosphatides in the present report. The contracted formulæ are :—

Oleo-palmito-glycero-neuro-phosphatide,
$C_{42}H_{82}NPO_8$.

Oleo-margaro-glycero-neuro-phosphatide,
$C_{43}H_{84}NPO_8$.

Oleo-stearo-glycero-neuro-phosphatide,
$C_{44}H_{86}NPO_8$.

Of the second lecithin there have been analysed the following salts :—

$C_{43}H_{84}NPO_8 + CdCl_2$
$C_{43}H_{84}NPO_8 + HCl$
$2(C_{43}H_{84}NPO_8 + HCl)\ PtCl_4$

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In the chemolyses the *oleic, margaric, palmitic,* and *stearic acids* were isolated, *oleic acid* characterising the phosphatide; stearic acid was always present in very small quantity only; it was probable that of stearic acid the *two isomers* discovered in these researches may sometimes be present in lecithins. Regarding the reputed identity of margaric and palmitic acid, I still entertain some doubts, which have been rather increased than diminished by the discovery of the isomers alluded to. Besides these acids the lecithins always yielded *glycerophosphoric acid* and *neurin*. The lecithins are easier to chemolyse than any other phosphatides, but on the whole I do not think them so labile as they are reputed to be, and as, in consequence of my earliest experiments, I believed them to be. The employment of the cadmium chloride, of the benzol process, and other improvements in manipulation, have no doubt a share in this better conservation.

Group of Paramyclins.

N : P = 1 : 1

Paramyelin was recognised in the first research, but fully isolated only in the present one. The properties by which it is diagnosed and separated from the other phosphatides have been fully described in the relative chapters of the present report, but its chemolysis has not been undertaken.

Paramyelin $CdCl_2$, human $C_{34}H_{68}NPO_8 + CdCl_2$
Paramyelin $CdCl_2$, ox $C_{38}H_{76}NPO_9 + CdCl_2$

It is not maintained that the compounds are unitary, and do not contain one or more similar principles, analogous to and homologous with the foregoing.

Paramyelin also forms a hydrochlorate platinochloride salt.

Group of the Myelins.

N : P = 1 : 1.

Myelin is a very firm compound, and according to its elementary composition belongs to the kephalin and lecithin-like bodies. But it must be left to be decided by chemolytic study, whether this is actually the case or not. Myelin has, on the whole, the properties of a dibasic acid, and combines with an atom of lead in substitution for two atoms of hydrogen. On the other hand it does not combine with cadmium chloride. Paramyelin, which presents the most similarity to myelin in its physical characters, on the contrary, does not combine with lead, but combines with cadmium chloride. Kephalin, on the other hand, combines with both these reagents, though the compounds are not always definite, as has been fully exhibited.

Myelin - - - $C_{40}H_{75}NPO_{10}$, in lead salt.
Myelin - - - $C_{39}H_{77}NPO_9$, free.
Myelin-lead - - $C_{40}H_{73}PbNPO_{10}$.

There may be myelins varying in carbon from 39 to 44 atoms. The reason for these variations can be discovered only by chemolysis.

B.—*Dinitrogenised Monophosphatides.*

N : P = 2 : 1.

Group of Amidomyelins.

With regard to this group, it is not necessary to repeat any of the details which are fully set forth in the present report.

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An amidomyelin has been proved to exist in five forms, one of isolation, four of combination :—

Amidomyelin - - - -	$C_{41}H_{83}N_2PO_9$.
Amydomyelin hydrochlorate - - -	$C_{41}H_{83}N_2PO_9$, HCl.
Amidomyelin monocadmium chloride - -	$C_{41}H_{83}N_2PO_9$, $CdCl_2$.
Do. Dicadmium chloride - -	$C_{41}H_{83}N_2PO_9 + 2$ ($CdCl_2$).
Do. Hydrochlorate platinochloride -	$2(C_{41}H_{83}N_2PO_{91} + HCl) + PtCl_4$.

Amidomyelin has not yet been chemolysed.

Group of Amidokephalins.

See notice and formula under kephalin in this chapter.

Group of Sphingomyelins or Apomyelins.

The details of the analysis and theory of these remarkable bodies are fully set forth in the present report. They are distinguished from the amidomyelins by containing a much higher proportion of carbon in relation to nitrogen and phosphorus; they yield no glycerol or glycerophosphoric acid on chemolysis, but contain an alcohol with perhaps 18 carbon atoms in its molecle, which may occupy the place in the phosphoryl radicle, which in the lecithin-like bodies is occupied by glycerol.

Sphingomyelin (ox) - - -	$C_{52}H_{104}N_2PO_9 + H_2O$.
Apomyelin (man) - - - -	$C_{54}H_{109}N_2PO_9$.
Sphingomyelin (theory from chemolysis)	$C_{58}H_{115}N_2PO_7 + 2\,H_2O$.
Sphingomyelin cadmium chloride - -	$C_{51}H_{99}N_2PO_{10} + CdCl_2$.
Do. dicadmium chloride -	$C_{51}H_{99}N_2PO_{10} + 2$ ($CdCl_2$).

Derivates by Chemolysis.

Sphingomyelic acid (mononitrogenised) -	$C_{48}H_{95}NPO_{12}$.
Sphingosin - - - -	$C_{17}H_{35}NO_2$.
Base (as sulphate) - - -	$C_{20}H_{41}NO_2$,
Sphingol, a new alcohol - - -	$C_{18}H_{36}O_2$, or $C_9H_{18}O$.
Sphingostearic acid (m.p. 57°) - -	$C_{18}H_{36}O_2$.
Neurin - - - - -	$C_5H_{13}NO$.
Nitrogenised product - - -	$C_{35}H_{81}NO_5$.
Phosphoric acid - - - -	H_3PO_4.

C.—*Dinitrogenised Diphosphatides.*

N : P = 2 : 2.

Of this order there is at present only one representative known, and that one as platinum salt only.

Assurin (theory) - -	$C_{47}H_{101}N_2P_2O_{11}$.
Do., hydrochlorate platinochloride	$2(C_{47}H_{101}N_2P_2O_{11} + HCl)\,PtCl_4$.
Assurin (theory) - - -	$C_{46}H_{94}N_2P_9O_9$.
Do., hydrochlorate platinochloride	$2(C_{46}H_{94}N_2P_2O_9 + HCl)\,PtCl_4$.

The phosphatides are the nucleolar materials in all structures which serve the purposes of multiplication, growth, and sentient and contractile existence. They are present in every particle of bioplasm and in every product of bioplasm. Thus the blood-corpuscles contain both mono- and dinitrogenised phosphatides. The bile, a product of the liver cells, contains a monophosphatide which is perhaps tetra-nitrogenised. Still higher nitrogenised is the phosphatide excreted by the lactiferous glands, casein, the material from which all tissues can be constructed. To this class belong the bodies which have been as yet imperfectly

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recognised, and which from the fact of their constituting the greater part of the nuclei of both animal and vegetable cells have been termed nucleins. It is now evident why organisms at all stages of their growth require phosphorus as a never-failing element of their food; why bacteria thrive best when they have penetrated to the nucleolar elements of bioplasm; why the diminution of phosphates in the body produces general marasm of all tissues, the brain and bones included.

Nitrogenised Non-Phosphorised Principles.

Group of the Cerebrosides.

Phrenosin - - - $C_{41}H_{79}NO_8$.

Of this body, which was discovered in the course of these researches, the composition, theory, and chemolytic products have also been discovered and fully described.

Definition and Formula of Constitution of Phrenosin.

Neurostearo-sphingoso-cerebroside.

Saccharoid radicle $C_6H_{10}O_4$. { Fatty acid radicle $C_{18}H_{35}O_2$. Alkaloid radicle $C_{17}H_{34}O_2$.

Derivates by Chemolysis and Synthesis of Products.

Cerebrose - - -	$C_6H_{12}O_6$.
Neurostearic acid - -	$C_{18}H_{36}O_2$.
Neurostearic ether - -	$C_{20}H_{40}O_2$. or $(C_2H_5)C_{18}H_{35}O_2$.
Sphingosin - - -	$C_{17}H_{35}NO_2$.
Do. sulphate - -	$2(C_{17}H_{35}NO_2)H_2SO_4$.
Do. hydrochlorate -	$C_{17}H_{35}NO_2,HCl$.
Psychosin - - -	$C_{23}H_{45}NO_7$.
Do. sulphate and hyhrochlorate -	
Aesthesin - - -	$C_{35}H_{69}NO_3$.
Nitrited phrenosin nitrate -	$C_{41}H_{79}N_3O_{13}$, or $C_{41}H_{78}(NO_2)NO_8+HNO_3$.
Caramel of phrenosin - -	$C_{41}H_{71}NO_4$.
Caramel of psychosin - -	$C_{23}H_{37}NO_3$.

Kerasin may, like phrenosin, comprise a number of analogously constituted bodies, of which the most probable formulæ are:—

Kerasin - - -	$C_{42}H_{85}NO_8$.
Do. - - -	$C_{44}H_{89}NO_8$.
Do. - - -	$C_{46}H_{92}NO_9$.

Products by Chemolysis.

Psychosin, as sulphate - -	$2(C_{23}H_{45}NO_7)H_2SO_4$.
Cerebrose - - -	$C_6H_{12}O_6$.
Fatty acids of the formula -	$C_nH_{2n}O_2$.

Group of the Cerebrinacides.

Cerebrinic acid may be a cerebroside in which three hydroxyls are replaced, two by fatty acid radicles, one by an alkaloid radicle.

Cerebrinic acid - - -	$C_{59}H_{113}NO_9$.
Caramel of cerebrinic acid - -	$C_{59}H_{105}NO_5$.
Spherocerebrin - - -	$C_{58}H_{123}NO_{17}$.
Principal cerebrinacide - -	$C_{55}H_{113}NO_{21}$.

Second cerebrinacide under investigation.

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Group of Cerebrosulphatides.

Bodies containing *sulphur* (maximum found 4 %) and occurring with cerebrinacides in the lead salts of the latter.

Cerebrosulphatide under investigation.

Group of Amidolipotides or Nitrogenised Fats.

Bregenin - - - - $C_{40}H_{81}NO_5$.
Krinosin - - - - $C_{38}H_{77}NO_5$.

Homology of these two bodies, which is suggested by a comparison of the formulæ, may not be assumed, as the one with the higher number of carbon atoms fuses at a much lower temperature than the one with the lesser number of carbon atoms.

Group of Alkaloids.

Hypoxanthin - - - - $C_5H_4N_4O$.
Do. hydrochlorate - - - $C_5H_4N_4O, HCl + H_2O$.
Do. do. with platinum-chloride - - $2(C_5H_4N_4O, HCl)\ PtCl_4$.
Do. nitrate - - - - $C_5H_4N_4O, HNO_3$.
Do. and silver nitrate - - $C_5H_4N_4O, Ag\ NO_3$.
Do. and silver - - - $C_5H_4N_4O, Ag_2$.

Hypoxanthin and its compounds were known in science, but isolated with greater precision from brain, particularly by the phosphomolybdic acid process.

Second alkaloid - - - - $C_{15}H_{20}N_6O_5$.
Do. hydrochlorate gold chloride - $C_{15}H_{20}N_6O_5, HCl, Au\ Cl_3$.
Third alkaloid - - - - C_3H_4NO.

Group of Amido Acids and Imides.

Leucin and allied principles - - - $C_6H_{13}NO_2$.
Do. and copper (monocupric dileucin) - $2(C_6H_{12}NO_2)\ Cu$.
Tyrosin - - - - - $C_9H_{11}NO_3$.
Do. and mercury nitrate compounds.

These bodies, otherwise well known in science, were for the first time isolated from the brain in the course of these researches. Urea was, isolated from brain and cerebrospinal fluid, particularly in disease.

Non-nitrogenised Alcohols.

Cholesterin, m.p. 145° - - $C_{26}H_{44}O$.
Phrenosterin, m.p. 137° - - $C_{26}H_{44}O$.
Inosite - - - - $C_6H_{12}O_6$.
Do. tricupric trihydrate - - $C_6H_{12}O_6 + 3\ CuO + 3\ H_2O$.
Do. a peculiar one from human brain.

Non-nitrogenised Organic Acids.

Formic acid - - - - CH_2O_2.
Sarkolactic acid - - - - $C_3H_6O_3$.
Do. zinc, calcium and barium salts
Succinic acid - - - - - $C_4H_6O_4$.
Do. iron and barium salts.
New tribasic acid - - - $C_3H_8O_4$.
Do. silversalt - - - $C_3H_5Ag_3O_4$.

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NITROGENISED-SULPHATIDE-PHOSPHATIDES.

These substances could be examined with advantage only after all the foregoing were known. They have been studied in the first instance by chemolysis, and have yielded very remarkable results.

Derivates by Chemolysis.

Albuminol.
Volatile sulphurised body.
Ammonia and compound ammonias.
Fatty acid.
Oxalic acid.
Phosphoric acid.
Sulphurous acid.
Acetic acid.
Alkaloids.

Leucein - - -	- $C_6H_{11}NO_2$.
Second alkaloid - -	- $C_{12}H_{25}N_3O_7$.
Do. copper compound	- $C_{12}H_{25}CuN_3O_7$.

Third alkaloid.

Amido acids.

Leucin - - -	- $C_6H_{13}NO_2$.
Do. copper compound	- $2(C_6H_{12}NO_2)$ Cu.
Glycoleucin - -	- $C_6H_{13}NO_2$.
Do. copper compound	- $2(C_6H_{12}NO_2)$ Cu.

The cupric compounds are *isomeric* as well as the leucins themselves.

Imides:

Tyrosin - - -	$C_9H_{11}NO_3$.
Do. calomel mercuric oxyde	$2(C_9H_{10}NO_4+HgCl)+HgO$.

INORGANIC INGREDIENTS OR MINERAL SALTS.

Metals.—Sodium, potassium, calcium, magnesium, iron, manganese, copper.

Metalloids.—Chlorine, sulphur, phosphorus, carbon (the last three as oxygen acids).

These salts are distributed as soluble and insoluble salts over the albuminous, phosphatide, cerebroside, and extractive substances.

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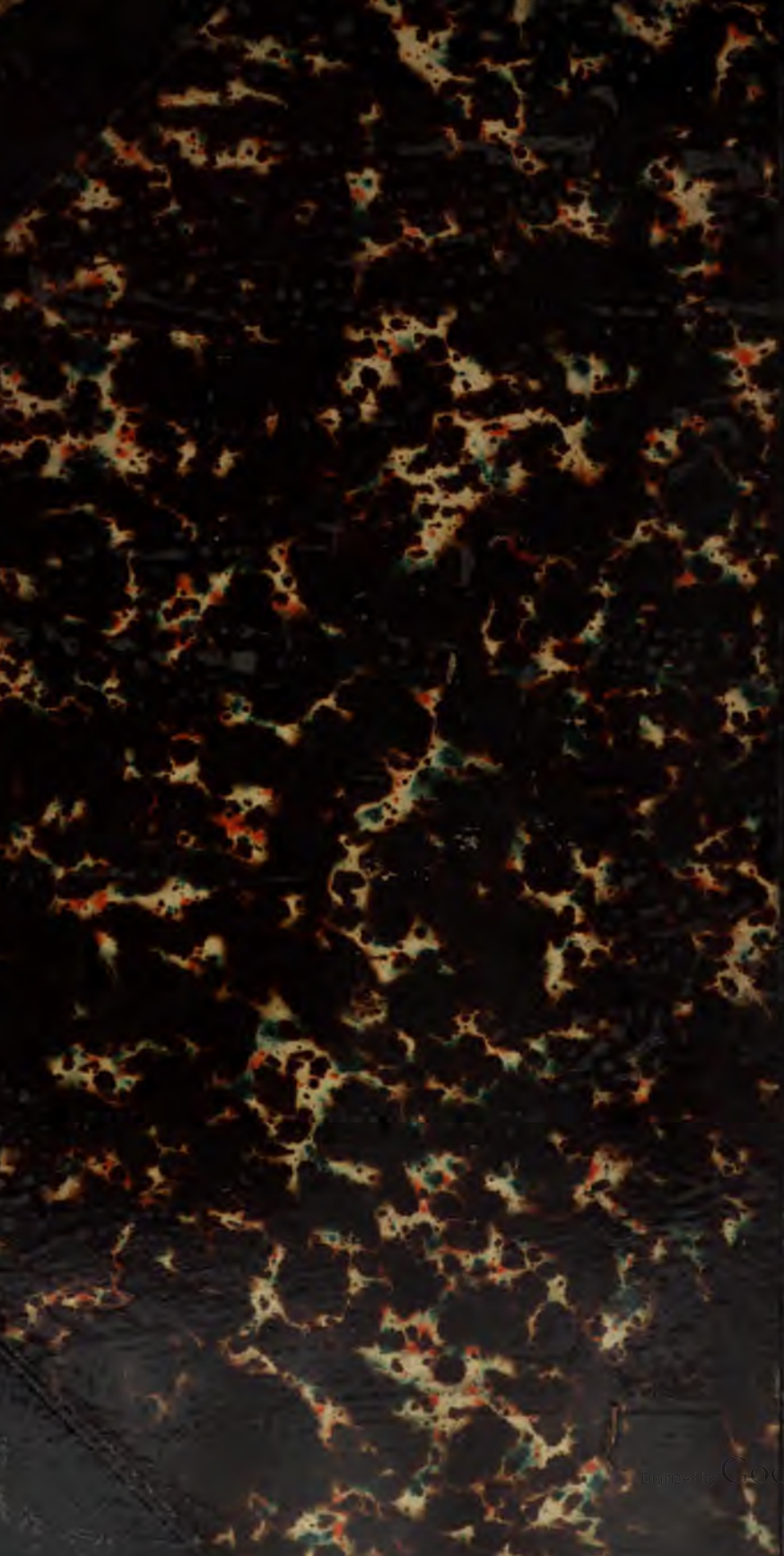
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